

How Powerful Are Elements ?

An Evaluation of the Adequacy of Element Theory in

Phonological Representations

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Abstract

In this dissertation, I resume the discussion of privative features as a notational device in segmental representation. I argue from both theoretical and empirical perspectives that element theory is a better theory of phonological representation than the binary-feature system. First, I argue that element theory is a more constrained and thus preferable theory since, with the proposal of single-valued features and a small element inventory, it is exempted from overgeneration of natural classes and phonological processes. Next, in case studies, I weigh the element-based representations of vowel shift, vowel harmony and consonantal lenition against the feature-based representations. The result of the evaluation shows that, compared to binary approaches, element theory is better in capturing the nature of various phonological processes. It generally provides non-arbitrary representations that can mirror how the processes occur, though it also has its limit in the characterization of Pasiego height harmony and consonantal affrication as well as providing a non-arbitrary account for occurrence of certain types of lenition in particular environments.

§ 1 Introduction

Phonological theories generally concern with two main issues –the representations and derivations of phonological processes. Throughout the history of phonological theory, they have received different degrees of attention from phonologists. Ever since the publication of Chomsky and Halle's (1968) *The Sound Pattern of English* (henceforth SPE), the focus of phonological theory has been centred on phonological derivations, and the concept of binary features, which underlies the phonological formulations proposed in SPE, has been regarded as the orthodox way of representing segments. However, in the 1980s and early 1990s, some phonologists noticed the limitations of binary features as a notational tool in phonological representation and thus proposed several theories of representation based on single-valued features, as in Dependency Phonology (e.g. Anderson & Jones 1974), Particle Phonology (e.g. Schane 1984a) and Government Phonology (e.g. Kaye et al. 1985; Harris 1990). Nevertheless, with the proposal of Optimal Theory in the mid 1990s, the focus of phonology has returned to derivations again.

However, phonological representation is the basis of derivation and should have received more attention, as McCarthy (1988:84) claims, the emphasis of phonology 'should be placed on studying phonological representation rather than rules', because 'if representations are right, then the rules will follow.' As a result, this dissertation aims to resume the discussion of segmental representation and re-evaluate the single-valued feature system (i.e. element theory¹) as a representational device. The organization of this dissertation is as follow. In §2, I introduce the basic assumptions of element theory and argue from a theoretical perspective that element theory is a

¹ The term 'element theory' is mainly associated with Government Phonology, yet I will follow Harris and Lindsey (1995) to use the term in a more general way, as a cover term of any segmental representation approaches based on privative features.

more constrained and thus preferred theory of representation. I will begin my argument with the motivation for segmental representation (§2.1) and then introduce the three basic vocalic elements – [I], [U] and [A] (§2.2). Next, I will discuss in details three important aspects of element theory and compare them with corresponding aspects of the binary-feature system (§2.3). Then, I introduce three theories based on single-valued features (§2.4), including Particle Phonology, Dependency Phonology and Government Phonology. However, I do not intend to offer a full description of these theories given the limited space. Instead, I will only introduce the fundamental assumptions and some devices that will be relevant to the case studies in §3. Three kinds of phonological processes will be discussed in details in §3, including vowel shift, vowel harmony and consonantal lenition. I will look at how different processes are accommodated within element theory and traditional binary approaches. As the discussion goes, I wish to show that element theory is not only preferred on a theoretical basis but also provides better representations for a wide range of phonological processes.

§ 2 Theoretical background

§ 2.1 Internal structure of segments

The whole business of segmental representation is developed out of the idea that segments are composed of smaller units just as words are composed of phonemes. These smaller units serve to express contrasts between segments, and the evidence of their existence can be found in the recurrent phonological processes throughout the history of languages in the world. A common example is the place assimilation of nasals, where a nasal assimilates itself to the following consonant with regard to place of articulation, as can be seen in Table 1. I base the following discussion of this

phenomenon on Ewen and van der Hulst (2001).

Spanish	u[m] pato	‘a duck’	(labial)
	u[n] topo	‘a mole’	(alveolar)
	u[ŋ] gato	‘a cat’	(velar)
(Clements 2006)			
Japanese	ho[m]pou	‘basic salary’	(labial)
	ho[n]tou	‘really’	(alveolar)
	ho[ŋ]kou	‘main school’	(velar)

Table 1 Place of assimilation of /n/ in Spanish and Japanese

Table 1 can be simplified in the form of a linear rule as follows:

$$(1) \quad /n/ \rightarrow \left\{ \begin{array}{l} [m] / __ /p/ \\ [n] / __ /t/ \\ [\eta] / __ /k/ \end{array} \right\}$$

The above representation shows the inputs and outputs of the operations and the environment where the changes occur. We can see that these assimilation processes occur in the same environment cross-linguistically, that is, in front of /p, t, k/. The fact that it is /p, t, k/ instead of, say, /p, t, l/ that recurrently trigger assimilations in different languages indicates that the former set form a group that can be addressed by phonological processes. A group of segments that participates recurrently in phonological processes are identified by phonologist as a ‘natural class’, the members of which have at least one property in common. In the present case, /p, t, k/ are all voiceless stops, while /l/ does not belong to this category.

However, a representation like (1) is not very enlightening because it does not show the correlation between the outputs and the environments. We cannot see, for example, why /n/ would become [m] instead of other segments when followed by a /p/. From the fact that the resulting pronunciations are still regarded by native speakers of the languages as realizations of the same phoneme /n/, and that /n/ only changes slightly and is not turned completely into the following segment, we can deduce that merely part of the nasal and part of its following consonant participate in the assimilation processes, which can only be achieved if segments are decomposable into smaller units. We are then faced with a question: What is it, if not the segment as a whole, that actually participates in the operation and is shared by the resulting nasal and following consonant?

In order to gain insight to the components that are active in the processes, we need to re-express the segments in terms of their internal structure, to describe the processes in a more revealing way. Thus, the phenomenon in Table 1 can be formulated as follows:

$$(2) \quad [\text{nasal}] \rightarrow \left\{ \begin{array}{l} [\text{labial}] / ___ [\text{labial}] \\ [\text{alveolar}] / ___ [\text{alveolar}] \\ [\text{velar}] / ___ [\text{velar}] \end{array} \right\}$$

(Ewen & van der Hulst 2001:7)

In (2), the correlation between the post-change nasals and the environments as well as the components that take part in the process are clearly shown. The nasal is labialized under the influence of a following labial consonant, same with the other two processes. However, a linear representation as (2) gives rise to a theoretical problem. That is, it is equally easy to form some ‘crazy rules’ (Bach & Harms 1972) that could not possibly

happen in any language simply by substituting the formulations with other components, as in (3).

(3)

$$[\text{nasal}] \rightarrow \left\{ \begin{array}{l} [\text{labial}] / ___ [\text{alveolar}] \\ [\text{alveolar}] / ___ [\text{velar}] \\ [\text{velar}] / ___ [\text{labial}] \end{array} \right\}$$

(Ewen & van der Hulst 2001:8)

While rules expressed in formulation (2) are natural in that they are recurrent phenomena cross-linguistically, processes in (3) lack such ‘universality’ (Schane 1972). However, both (2) and (3) are equally easy to formulate in spite of the difference in the degree of naturalness, which implies that such type of representation is unable to distinguish between recurrent and non-recurrent phonological processes, a ‘fundamental theoretical inadequacy’ of linear representation recognized by Chomsky and Halle (1968:400) themselves. In other words, though such type of representation seems to have achieved some degree of ‘descriptive adequacy’, it suffers from the problem of overgenerating phonological processes (Rennison 1984:281). That is, many processes that are expressible in this framework, such as those in (3), are not even attested in the history of languages. Yet a powerful phonological theory should not only reach the level of descriptive adequacy but more importantly that of ‘explanatory adequacy’ (SPE:335). It should be able to distinguish recurrent processes from non-recurrent ones by allowing the former to be formulated in a simpler way than the latter in its representation and therefore make prediction about possible phonological processes. The above representation, however, lacks such capability.

§ 2.2 Segmental representation

From the previous section we can derive several basic requirements for an adequate phonological representation theory: (i) A set of segments that recurrently participate in phonological processes should be definable as a natural class in terms of the components shared by the segments (Lass 1984). (ii) The system should allow recurrent and natural phonological processes to be expressed in an easier way than non-recurrent and unnatural ones (SPE; Anderson & Ewen 1987). In this section, I will introduce element theory, a representation-based theory that is different from the traditional linear approach based on binary features, and in the next section I will discuss how well the above two requirements are embodied in this theory.

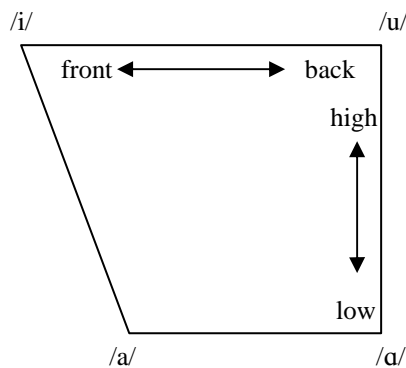
§ 2.2.1 *Basic elements I, U, A*

Phonological theories based on single-valued features generally establish their proposals on three basic elements: [I], [U] and [A]. Within this framework are Particle Phonology (Schane 1984a), Dependency Phonology (Anderson & Jones 1974; Anderson & Ewen 1987; van der Hulst 1989) and Government Phonology (Kaye et al. 1985; 1990; Harris 1994a; Harris & Lindsey 1995). Although there are certainly differences among these theories with respect to how the three basic elements are utilized to characterize various phonological processes, which I will elaborate in §2.4, some fundamental assumptions of these theories are the same.

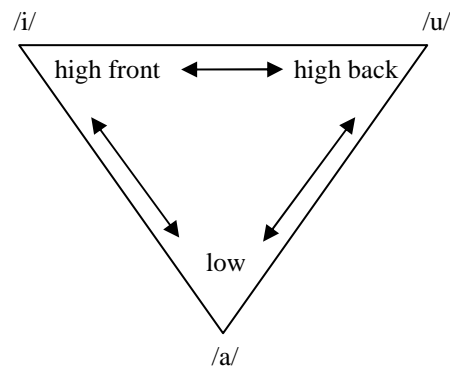
We have seen in §2.1 that segments are composed of smaller units, but what are these units? It turns out that different theories employ different sets of features, especially for the representation of consonants, yet the proposals of vocalic features can be generally divided into two types. SPE-type approaches define vowels in terms of two ‘bidirectional’ contrasts, high-low and front-back, which together define a rectangular vowel space, while in element theory, the three elements [I], [U], [A] form

a ‘tridirectional’ relationship, defining a triangular vowel space with three corners—‘high front’, ‘high back’ and ‘low’ respectively (Rennison 1984), as shown in (4).

(4)



(a) Vowel space in a binary feature system
(Giegerich 1992:15)



(b) Vowel space in element theory

The two systems differ not only in the shape of vowel space they define and the parameters they utilize but also the phonetic interpretability of the features. In the binary feature system, the definition of any given vowel requires the specification of both height and frontness/backness; that is, a feature on its own cannot define any segment. Yet in element theory, each element in isolation is phonetically interpretable. The three corners of the triangle are defined by the three basic elements [I], [U], [A], manifesting themselves as /i/, /u/, /a/ respectively.

Elements can also combine with each other to form ‘compound’ segments (Kaye et al. 1985) to represent other vowels, which have more complex internal structures than the vowels represented by the three basic elements but are equally phonetic interpretable. Thus, exploiting the combinatorial possibilities, we can derive a list of possible vowels as follows:

(5)

/i/	[I]	/e/	[I, A]	/ø/	[I, U, A]
/u/	[U]	/o/	[U, A]		
/a/	[A]	/y/	[I, U]		

(Anderson & Ewen 1987; Harris 1994a)

The combinatory possibilities can be further extended in the mechanism of dependency relations between elements, as proposed in Dependency Phonology and Government Phonology. In this mechanism, elements can enter into a relationship where one element is more prominent than the other. The more prominent element (head) contributes more of its property while the less prominent (dependent) one contributes less. For example, /e/ and /æ/ in a vowel system that contains both of them would be represented as [I, A] and [I, A] respectively, where the underlined elements are the head. Notice that the representation of /e/ here is different from that in (5), a system that lacks /ɛ/ and /æ/, because phonetic interpretation of elements in element theory is ‘system-dependent’ (van der Hulst 1992:123); that is, it is adjustable to the phoneme system of a language.

There are several pieces of evidence in support of the proposal of [I], [U], [A] as the basic elements. First, the primary vowels /i/, /u/ and /a/ each occupies a corner of the vowel triangle of human oral cavity and thus are maximally distinct with regard to articulation (Dikken & van der Hulst 1988). Hence, all other vowels should be definable as they fall within the triangle.

Second, the three vowels are recognized by Stevens (1972; 1989) as the ‘quantal’ vowels (Anderson & Durand 1986; Dikken & van der Hulst 1988). According to his observation, these vowels are relatively stable because they can be realized through a wide range of articulatory configurations while causing little change in acoustic

effects. Other vowels, by contrast, require more precise configurations. This corresponds to the proposal that representations of the primary vowels require less specification.

Third, phonological processes addressing the three basic elements individually are well-attested across languages (Harris & Lindsey 1995), several of which are mentioned in Jones (1989). For example, in the Anglian dialects of Old English, short front vowels [æ], [e] and [i] in a stressed syllable acquire backness/labiality when followed by labial sonorants, which can be represented as the spreading of [U], while in West Saxon Old English, it is the [I] that spreads from /i/ and /e/ to the vowel in a preceding syllable, making [u] → [y] and [o] to [œ]. Harmony processes involving element [A] can be found in Kinande (Clements 1991), a Bantu language, where vowels raise one degree before the root vowels /i, u/, which can be characterized as the loss of [A].

§ 2.3 Important aspects of element theory

In this section, I discuss several important assumptions underlying element theory, including the use of single-valued element, the preference for a small feature inventory and the acoustic basis of features. I will pay attention to arguments in support of these assumptions while also making reference to some against them.

§ 2.3.1 Privativity (Monovalency)

§ 2.3.1.1 Privative vs. Equipollent

The notion of privativity in phonology can be traced back to Trubetzkoy (1969:75), where he defined a privative opposition as ‘oppositions in which one member is characterized by the presence, the other by the absence, of a mark’, while in an

equipollent oppositions, ‘both members are logically equivalent’; that is, both members are existent. These two types of relation represent a fundamental difference between the element-based approach and the traditional binary-feature approach to segmental representation. In a binary-feature system, each feature is specified with either value + or -, both of which are accessible to phonological processes, while within element theory, all elements are single-valued, and thus only the presence of an element is addressable by phonological processes. Take the feature [\pm nasal] for example, in binary framework, it is assumed that there are processes addressing a natural class defined by [+nasal] as well as processes addressing a class defined by [-nasal], yet in the privative framework, only the natural class defined by the presence of [nasal] (i.e. [+nasal] in binary terms) are allowed in the formalism and thus there are no processes addressing a class defined by the absence of [nasal]. As a consequence, a binary-feature approach essentially defines more natural classes and allows more possible processes (Harris 1994a). The choice between the binary and the privative approach then depends on: (i) whether both natural classes defined by the two feature values have equal chance to participate in phonological processes, and (ii) whether both values of a feature are equally active in phonological processes.

§ 2.3.1.2 *Asymmetry between feature values*

Whether both values of all features are equally accessible to phonological generalisation has long been an issue under debate. Dependency Phonology (e.g. Anderson & Ewen 1987) claims that all features are privative, while SPE, by contrast, follows a strict binary-feature approach. To answer the first question raised in the above paragraph, we pick up the [nasal] example again. Though the natural class defined by [+nasal] participate recurrently in phonological processes cross-linguistically, processes addressing a class defined by [-nasal] are not attested

(Ewen & van der Hulst 2001). Thus, it has been widely accepted that the binary approach suffers from overgeneration of natural classes.

As for question (ii) raised above, it is found in many studies that the two feature-values are not equally active in phonological processes. For example, in the case of vowel harmony in Khalkha Mongolian, Steriade (1979) recognizes an asymmetry between the distributions of the two values of [\pm round]. There are two harmony processes in this language, Backness Harmony and Rounding Harmony. The Backness Harmony requires that all vowels agree in backness, yet only a front vowel [i] which appears in a non-initial position of a stem that otherwise contains all back vowels can be exempt from the harmony. The Rounding Harmony states that a non-high vowel will be rounded immediately following a non-high round vowel while neglecting any intervening [i] (Goldsmith 1985:256). According to Steriade's (1987; also reported in Archangeli 1988) analysis, only [+round] is active in the process, since it is [+round] that spreads in the harmony and the condition under which a non-high vowel can escape being rounded is either following word-initial [+high] vowels or immediately after a [+high, +round] vowel.

§ 2.3.1.3 Markedness and Underspecification

The asymmetrical status between the two feature-values, as in the case of [\pm round] above, is treated within the framework of underspecification (e.g. Kiparsky 1985; PulleyBlank 1988), where the predictable and thus unmarked feature-value is omitted in the underlying representation, and is only specified during the derivation of phonetic implementation by a default rule, which fills in the unmarked value of a feature. However, though the binary-feature formalism is preserved in such framework, the fact that only one value is preferred by phonological processes seems to imply a privative opposition (Dikken & van der Hulst 1988:35). A question then

arises: ‘whether underlying unspecified values are *ever* specified?’ (Archangeli 1988: 189, italics original) Not much work on underspecification has considered seriously the necessity to fill in the unmarked values, yet if evidence of the necessity cannot be provided, any argument for underspecification would turn out to be one in favour of the privative approach (Lombardi 1996).

Taking into consideration the cross-linguistic phenomenon of ‘redundant’ feature-values (Steriade 1987), the privative approach simply lets the unmarked value be characterized by the absence of an element, which renders default rules superfluous (Kaye et al. 1990). Thus, in the Khalkha Mongolian case, there will no longer be a rule which fills in [-round] as the default value during the derivation, since all resulting vowels of the harmony will automatically be unround except for those specified as [round]. As a result, van der Hulst (van der Hulst 1989:199) regards the privative approach as the ‘logical end point of Radical Underspecification’. Nevertheless, it is not merely an alternative to underspecification but a solution to the problem of overgenerating phonological processes mentioned at the end of §2.1. From the fact that only the marked value of a given feature is recurrently addressed by phonological processes, we can derive that those addressing the unmarked value are non-recurrent, and thus the reason why binary approaches suffer from overgeneration of phonological processes is that processes addressing an unmarked value are equally expressible in the representation as those addressing the marked value. Yet in the element framework, non-recurrent processes simply cannot be formulated since the representation cannot refer to the absence of an element, which makes element theory more constrained and thus more highly valued than binary approaches in that non-recurrent processes are systematically excluded from the representation as inexpressible and thus impossible phonological processes. As a result, what SPE refers to as the ‘intrinsic content of features’ (1968:400), namely the relative

markedness of feature-values, is directly built into the use of single-valued features (Harris 1994a). In other words, the marked value is characterized by the presence of a feature whereas the unmarked value by the absence of it. Therefore, no extra markedness conventions are in need within the element framework.

§ 2.3.1.4 Arguments against privativity

However, although many features have been shown to act in a privative way, such as [round] mentioned above, [low] (Goldsmith 1985), [back] (Steriade 1987), [nasal] (Steriade 1995) etc., arguments in support of the binary-feature system is also worth considering. For example, though it has been found in some languages that only [+voice] but not [-voice] can spread to other segments, as in Japanese (Itô & Mester 1988), Ukrainian (Danyenko & Vakulenko 1995; cited in Wetzels & Mascaró 2001), which leads to the conclusion that voicing is a privative feature, Wetzels and Mascaró (2001) reject this proposal with evidence from other languages where only [-voice] spreads in an assimilation process. They argue that in Yorkshire English and Parisian French, voiced obstruents become voiceless when followed by a voiceless obstruent but not vice versa, which can only be explained by the spreading of [-voice] because there is no rule of final devoicing in these two languages. Evidence from other languages is also mentioned in the same article to support the need for the specification of [-voice].

It is not the intention of this dissertation to examine all the arguments for and against privative features, but suppose the evidence proposed in favour of binarity is valid; that is, the processes cannot be reanalyzed in terms of privative opposition, it may be the case that some features are privative while some are binary, or even that the unmarked value of a feature is language-specific, as concluded in Steriade (1987). However, it is worth noticing that when comparing privative approaches with binary

approaches, we should make sure that the evaluation is made on a ‘level playing field’, since the sets of features proposed by different representation-based theories may not be identical (Harris & Lindsey 1995). Evidence in support of the binarity of a feature only used in binary approaches does not entail abandoning the privative approach. If a theory can show that a wide range of phonological processes can be explained in terms of the privative features it employs, it would be naturally considered a preferred approach due to its more restrictive generative capacity (Harris & Lindsey 1995).

§ 2.3.2 A small inventory of elements

Compared to the binary approaches, element theory is a more constrained theory not only in that it utilizes single-valued features but it also has a smaller feature inventory. It is obvious that, other things being equal, a smaller number of features would reduce the combinatory possibilities and thus generate fewer possible segments. In other words, the more features we propose, the more likely we may encounter combinations that generate universally impossible sounds due to natural constraints on human speech organs. An example commonly referred to is the universally incompatible combination of [+high, +low] in binary approaches. More often is the case where feature combinations formulate possible but unattested sounds on a language-specific basis, such as voiceless nasals in English, which would require some arbitrary statements to exclude unattested sounds from the inventory of the language (van der Hulst 1989). The excessive power of a large feature inventory provides a reason to reject the proposal of what Clements (2009:19) terms as a ‘direct-access’ theory of inventory structure (e.g. Browman & Goldstein 1989; Ladefoged & Maddieson 1996), which intends to provide ‘finer-grained categories’ of speech sounds based on the articulatory gestures and results in a large feature inventory.

Contrary to the proposal of phonetics-centred features is the idea of ‘distinctive

features' proposed by Jakobson et al. (1952, henceforth PSA), where a feature can only be proposed if it can specify a phonological contrast, i.e. if there is a pair of phonemes that differ only in the specification of the feature. For example, it is argued in PSA that, since no languages contrast between labialized, velarized and pharygealized consonants but only between either one of them with a plain consonant, there should be only one feature covering all three types of consonants, and thus Jakobson et al. propose a feature [flat] as the cover feature (reported in Hyman 1975). In a sense, the proposal of distinctive features implies a parsimonious view of feature inventory. However, Lass (1984:97) argues that such an 'reductionist strategy' may abstract phonological representations too far away from phonetics and then require complementary descriptions to specify which of the three articulatory gestures are actually involved in the processes. Therefore, though a small feature inventory is generally preferable as it is exempt from overgeneration of possible sounds, phonetics should also be taken into consideration in the proposal of feature set.

A similar concept to parsimony is 'feature economy' (Clements 2003a; 2003b; 2009), which proposes that languages maximize the use of features. Therefore, it predicts that phoneme systems tend to have more than one segment characterized by the same feature. Clements (2003b) supports this hypothesis with his research on the phoneme systems of the world's languages, which shows that feature economy is indeed a cross-linguistic principle of the organization of feature inventories. Thus he proposes an 'economy index' to measure the degree of feature economy, as formulated in (6), where E stands for the degree of economy, S for the number of sounds, and F for the number of features.

$$(6) E = S/F$$

According to the formulation, there are essentially two ways to achieve a greater economy: either by adding new sounds to the phoneme system (i.e. increasing S) or reducing the size of feature inventory (i.e. decreasing F). Though Clements rejects the equation of feature economy to parsimony because the latter is against an increase in the number of sounds, at least both prefer a smaller feature inventory.

As a result, from the perspectives of distinctive features and feature economy, element theory seems a preferred feature theory over binary feature systems, for it utilizes a smaller number of features to represent the same amount phonological contrasts. This result can be attributed to two innovations of element theory. First, elements are allowed to represent more than one property. For example, element [I] specifies frontness and palatality, and [U] represents roundness and labiality. Each of these properties requires a separate feature in the traditional binary system. The characteristics of multiple identities not only reduces the number of elements needed but also enables processes such as palatalization of consonants adjacent to a high front vowel to be represented in a more revealing way, which the SPE system fails to achieve, as pointed out by Campbell (1974). Another innovation leading to a smaller inventory is the proposal of dependency relationship (Van der Hulst 2006), which exploits the combinatory possibilities of a limited number of elements, as has been mentioned in §2.2.1. Together with the assumption that each element alone can specify a segment, which would require more than one feature in binary approaches, element theory uses its features in a more economical way.

§ 2.3.3 *Acoustic basis*

Unlike the articulation-centred SPE feature system, element theory can be regarded in a sense as a revival of Jakobsonian acoustic features (Harris & Lindsey 1995). However, element theory does not abandon the articulatory dimension but adopts a

neutral position in that elements are defined in terms of both articulatory gestures and acoustic properties, as in (7). ‘Acuteness’ is defined by the predominance of the upper side of the sound spectrum and ‘gravity’ by the predominance of the lower side of the spectrum. Namely, an acute segment has an F_2 closer to F_1 than F_3 , while in an grave segment, F_2 is closer to F_3 . ‘Compactness’, on the other hand, is defined by a high ‘phonetic power’, which is often associated with sonority (Anderson & Ewen 1987).

(7)

- I ‘frontness’ (or ‘acuteness’ and ‘sharpness’)
- U ‘roundness’ (or ‘gravity’ and ‘flatness’)
- A ‘lowness’ (or ‘compactness’)

(Anderson & Ewen 1987:28)

It has now been recognized in many discussions that both articulatory and acoustic dimensions need to be taken into consideration in the proposal of features. On one hand, Lass (1984) notices that labials and velars have often been addressed as a group by phonological events cross-linguistically, such as in Old English, Uralic languages and Middle Korean. The SPE system fails to present these two types of sound as a natural class, whereas PSA successfully characterizes them with a single feature [+grave]. On the other hand, Halle (2009:71), one of the authors of PSA, recognizes the difficulty of representing the palatalization of consonants before front vowels in Slavic languages in a revealing way with Jakobsonian features, as formulated below:

(8)

[-palatalized] → [+palatalized] / _____ [-grave]

Halle further points out that (8) fails to reflect the fact that such process is the spreading of frontness from the following vowels to the consonants, which can be expressed simply with the feature [\pm back] in the SPE system.

The reason for the failure of articulation-based features to represent some natural classes and phonological processes in a natural way is that, though some processes result from ease of articulation, there are also some that originate from the perception side of speech transmission. Evidence from acoustic phonology has shown that articulation and acoustics do not always form a one-to-one relationship. For example, Stevens (1972) found that there are some conditions where acoustic signals are relatively insensitive to change in articulation, and there are also conditions where a slight adjustment of articulation gives rise to significant change in acoustic effects. It is also mentioned in many publications (e.g. Lindau 1975; Halle 1983; Lass 1984) that there are cases where several articulatory gestures can be utilized to achieve the same acoustic effects.

Ohala (1981:178) claims that such ‘inherent ambiguity’ of the speech signal is a source of phonological change, such as the different realizations of the English *with* which range from [wiθ] to [wɪf] in various dialects, since [θ] and [f] are similar acoustically. This kind of process would be better characterized by features based on acoustics than on articulation, since it results from the listener’s misperception of the acoustic signals. And as Ohala (1996) also argues, speech perception is a process where a listener perceives sounds in the form of acoustic signals instead of articulatory gestures as proposed in the motor theory (Lieberman & Mattingly 1985). This statement can be further supported by psycholinguistic evidence (Dehaene-Lambertz & Pena 2001) which shows that 2-6-day neonates, though not capable of replicating what they hear, can discriminate sounds of different categories.

As a result, since acoustic signals are the medium of speech transmission,

element theory integrates the notion of Jakobsonian acoustic features into the definitions of elements. In so doing, it should be able to formulate more natural classes and phonological processes in a more revealing way than any feature theory with a strong bias towards either articulation or acoustics.

§ 2.4 Element-based theories

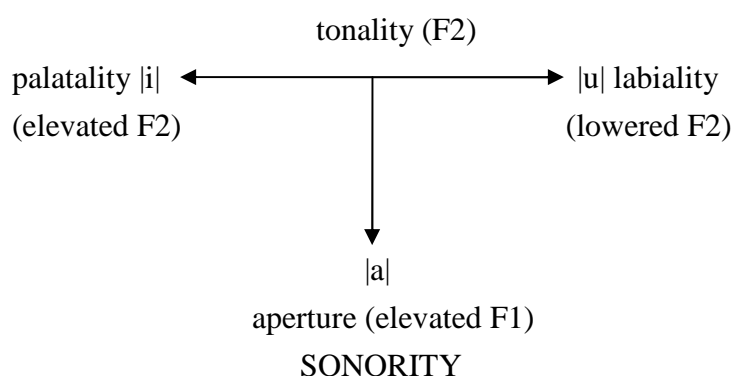
In this section, I introduce three element-based theories –Particle Phonology (PP), Dependency Phonology (DP) and Government Phonology (GP). They generally share the aspects discussed in the previous section, yet there are still differences in their element inventories and the formal apparatus they utilize. Thus, in order to support the case studies in the following chapter, I will look at some fundamental assumptions of each theory and introduce the descriptive devices relevant to the phenomena to be discussed in the next chapter.

§ 2.4.1 Particle Phonology

Particle phonology is mainly discussed in the work of Schane (1984a; 1984b; 1995; 2005). Thus, in the following, I will provide a summary of his proposal. As Schane claims, PP is a theory motivated by the failure of traditional binary systems to characterize the internal structure of vowels and the relationship between vowels and diphthongs. As a result, it is a theory proposed to deal with the representation of vowels.

Schane divides the three elements ('particles' in Schane's term) into two categories on the basis of formant frequencies: *i* and *u* are tonality particles and *a* is the aperture particle. In terms of articulation, *i* stands for palatality, *u* for labiality, and *a* for openness. Schane illustrates the definitions of the three elementary particles as follows:

(9)



(Schane 2005:338)

As in DP and GP, the three particles in PP individually manifest themselves as the three primary vowels, but PP is different from the other two theories in the representation of complex segments. The representation of vowel height has been pointed out as a problem of traditional binary system, which with two features [high] and [low] can only derive three vowel heights. Hence, a mid-low vowel in a system with four vowel heights would be classified arbitrarily as either [-high, -low] or [-high, +low] (Durand 1990:291). Some linguists (Ladefoged 1971; Sommerstein 1977; Lindau 1978) propose a multi-valued feature to represent the scalar property of vowel heights, marking the feature [high] with natural numbers to characterize various heights. Thus, the lowest vowel /a/ would be specified as [1 high], which is lower than the second lowest vowel, specified as [2 high], while the total number of heights needed depends on the system to be described. However, such proposal would undermine the radical position of binarism. PP, on the other hand, allows multiple occurrence of the aperture particle in the description of different vowel heights. In this way, PP is able to accommodate a scalar property within a privative system. Therefore, a vowel system with four front unrounded vowels is represented as in (10).

(10) Short vowels

/i/	i	/u/	u
/e/	ai	/o/	au
/ɜ/	aaɪ	/ɔ/	aaʊ
/æ/	aaai	/a/	aaa

To represent long vowels and diphthongs, Schane (1984a) proposes two punctuators: ‘space’ and ‘half-moon’. The extra length of long vowels is characterized by the addition of an extra tonality particle, following a space, to the end of corresponding short vowels, but for non-high central vowels, where no tonality particles are involved, an extra aperture is added instead. Thus, long vowels corresponding to (10) are represented below:

(11) Long vowels

/i:/	i i	/u:/	u u
/e:/	ai i	/o:/	au u
/ɜ:/	aaɪ i	/ɔ:/	aaʊ u
/æ:/	aaai i	/a:/	aaa a

Representation of diphthongs contains specifications of the two parts separated by a space, with a ‘half-moon’ marked under the glide. The specification at the two sides of the space each occupies a skeletal position. Some examples are shown in (12).

(12) Diphthongs

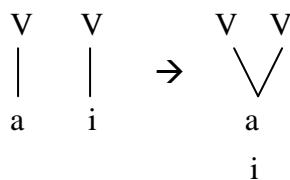
/ij̣/	i j̣	/uɥ̣/	u ɥ̣
/ej̣/	ai j̣	/oɥ̣/	au ɥ̣
/aj̣/	a j̣	/aɥ̣/	a ɥ̣

Schane argues that, compared to traditional binary system, the notational devices

of PP can better characterize processes involving alternations between monothongs and diphthongs. In Schane (1984a), he compares the representations of two phonological operations –fusion and fission –under PP and traditional binary system. ‘Fusion’, as defined by Schane, is the monothongization of a diphthong, whereas ‘fission’ is the opposite. For a fusion process such as /ai/ → /e:/, PP and traditional binary approach offer the following representations respectively.

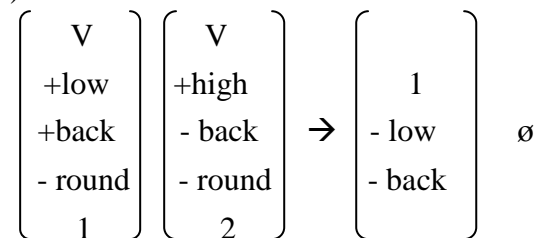
(13)

(a)



(Schane 1995:587)

(b)



(Schane 1984a:140)

Schane argues that formulation (13b) represents the process as a conversion of the first half of the diphthong into /e/ plus the loss of the second half instead of a fusion of the two segments of the diphthong as in (13a). He continues to point out that there is no correlation between the input and output of the process in (13b). We cannot see, for example, why [+back] becomes [-back] or why [+low] becomes [-low]. The specification of feature values seems to be arbitrary in this sense. By contrast, in (13a), the output is clearly shown as an amalgam of the particles present in the input, and vowels containing particles other than *a* and *i* would be excluded from possible output, which presents PP as a more restrictive theory than the binary system in the generation of possible outputs.

Furthermore, Schane (1984a) proposes three laws to constrain representations under PP. First, the law of mora conservation requires that the number of skeletal

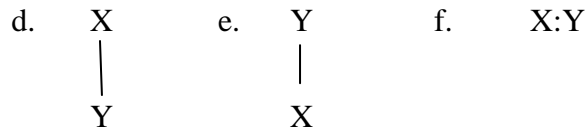
position be preserved during fusion and fission. Thus, a diphthong occupying two morae could not be fused into a short monothong. Second, the law of diphthongal differentiation demands that the two halves of a diphthong not be identical. Hence the two parts should differ at least in height or tonality. Third, the law of maximum aperture requires that the representation of /a/ should ‘not have fewer aperture particles than the lowest tonality vowels’ (Schane 1984a:139). Therefore, in a vowel system as the one in (10), since the lowest tonality vowel /æ/ contains three aperture particles, the vowel /a/ should be specified with three aperture particles as well.

§ 2.4.2 Dependency Phonology

As indicated by its name, the most salient innovation of DP is the use of dependency relationships among elements, or ‘components’ in DP’s terminology. I have already mentioned that in DP and GP, elements in a combination can enter into various head-dependent relations. With regard to the notation, DP uses a semi-colon or an arrow to represent dependency relationships. Dominating components are placed on the left side of a semi-colon or the end of an arrow, while a mutually dependent relationship, where none of the components are more preponderant than the others, is represented with a colon or double-headed arrow, as illustrated in (14a-c) (Dikken & van der Hulst 1988:8). When presented in the form of dependency trees, the head component resides in the top of the branch. Thus, (14d-f) correspond to (14a-c) respectively.

(14)

- a. $\{X;Y\}$ or $\{X \Rightarrow Y\}$ – Y is dependent on X
- b. $\{Y;X\}$ or $\{Y \Rightarrow X\}$ – X is dependent on Y
- c. $\{X:Y\}$ or $\{X \Leftrightarrow Y\}$ – X and Y are mutually dependent



Thus, exploiting all combinatory possibilities, we can represent a system with four front unrounded vowels and four back rounded vowels as follows:

(15)

$\{i\} = /i/$	$\{u\} = /u/$	$\{a\} = /a/$
$\{i;a\} = /e/$	$\{u;a\} = /o/$	
$\{i:a\} = /\epsilon/$	$\{u:a\} = /\text{ɔ}/$	
$\{a;i\} = /\text{æ}/$	$\{a;u\} = /\text{ɒ}/$	

(Anderson & Ewen 1987:31)

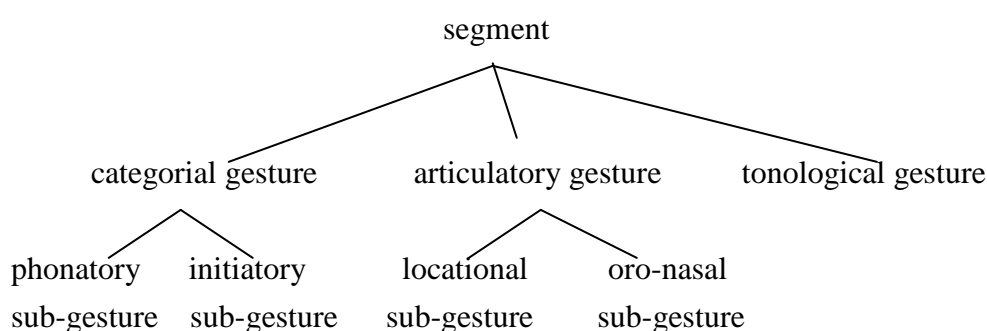
As a result, DP is more constrained than PP in the number of vowel heights it can generate (Durand 1990). In the latter system, there is no intrinsic limitation on the number of aperture particle a segment can contain, though Schane (1995:fn.17) does note that the aperture particle can generally occur at most three times since vowel systems with more than five degrees of heights are rare.

Another important aspect of DP is the grouping of gestures. It is motivated by the observation that features often participate in phonological processes in groups. For example, the place assimilation of nasals mentioned in §2.1 is not just several unrelated processes that happen to share the same input but a unified phonological event addressing place features as a whole (Clements 2006). Though SPE (1968:300) also uses terms such as ‘major class features’ and ‘cavity features’ to refer to classes

of features, they are proposed merely for ‘expository purposes’ but are not incorporated into formal representations (Anderson & Durand 1986:20).

DP, by contrast, classifies components into groups of gesture. Evidence supporting such proposal can be found in phonological processes. Lass (1976) argues that the reduction of English /p, t, k/ to the glottal stop [ʔ] and the voiceless fricatives to [h] indicates that gestures should be divided into at least two categories, since both processes involve the deletion of all articulatory gestures but leave the other features unaffected (Dikken & van der Hulst 1988). However, this does not imply that there can only be a maximum of two categories, as argued by Anderson and Ewen (1987). In fact, different approaches under DP may set up slightly different categories. In Anderson and Ewen’s (1987) proposal, components are categorized into three main groups: the categorial gesture, the articulatory gesture and the tonological gesture. The first group is further divided into phonatory sub-gesture and initiatory sub-gesture and the second into locational sub-gesture and oro-nasal sub-gesture, as illustrated in (16).

(16)



(Dikken & van der Hulst 1988:8)

Since it is impossible to explore the full range of components proposed in DP given the limited space, here I will only introduce the three vocalic components [i], [u],

|a| and the phonatory sub-gesture, which will figure in some discussions in §3. According to Anderson and Ewen's (1987) proposal, the three basic elements are posited under locational sub-gesture. As already mentioned, they can represent a wide range of vowels with different dependency relations, yet the three basic elements are not only used to characterize vowels but also consonants, where |i|, |u| and |a| specify the palatality/frontness, labiality/roundness and lowness/openness respectively.

The phonatory sub-gesture contains only two components, |V| and |C|, which specify the consonantality, voice, continuancy and sonorance of a segment. |V| is defined as 'relatively periodic' and independently represents the class of vowels, whereas |C| is defined as 'periodic energy reduction' which on its own characterizes voiceless plosives. These two components generally correspond to the features [vocalic] and [consonantal] in the PSA system, but the difference is that the presence of one phonatory sub-gesture does not necessarily entails the absence of the other; instead, |V| and |C| can enter into various dependency relations just as |i|, |u|, |a| in the representation of vowels. However, unlike the three basic elements, each of which can only occur at most once in a segment, phonatory components are allowed to appear up to twice in the representation of a segment type, but the two instances of the same component should not enter into a mutually dependent relation (Anderson & Durand 1986). Thus, some natural classes of segments can be represented in the form of dependency trees as follows:

(17)

V	V	V	V:C
	V:C	C	V
vowel	approximant	nasal	voiced fricative
V:C	C	C	
	V		
voiceless fricative	voiced plosive	voiceless plosive	

(Anderson & Ewen 1987:158)

§ 2.4.3 Government Phonology

GP shares with DP in the use of head-dependent relationship to characterize various complex segments, only in GP the headedness is expressed through an underlined element in the notation. According to Kaye et al.'s (1985) proposal, an element is an independently pronounceable constituent defined by a 'fully specified matrix' of phonological features, one of which is the salient feature of the element, termed as the 'hot feature'. For example, the three basic elements are defined as follows, with the salient feature underlined.

(18)

$$\begin{array}{lcl}
 \text{I} = & \left[\begin{array}{c} - \text{ROUND} \\ - \underline{\text{BACK}} \\ + \text{HIGH} \\ - \text{ATR} \\ - \text{LOW} \end{array} \right] & \text{U} = \left[\begin{array}{c} + \underline{\text{ROUND}} \\ + \text{BACK} \\ + \text{HIGH} \\ - \text{ATR} \\ - \text{LOW} \end{array} \right] & \text{A} = \left[\begin{array}{c} - \text{ROUND} \\ + \text{BACK} \\ - \underline{\text{HIGH}} \\ - \text{ATR} \\ + \text{LOW} \end{array} \right]
 \end{array}$$

(Kaye et al. 1985:306)

In the fusion of two elements, the hot feature of the dependent (‘operator’ in Kaye et al.’s terminology) substitutes for the corresponding feature value in the head, giving rise to a new matrix that defines a complex segment. For example, when [U] fuses with [A], with the former as the head, the feature [+ HIGH] in [U] would be replaced by the hot feature [- HIGH] in [A], which then forms a matrix specifying the vowel /o/. As in DP, [I], [U], [A] are also available for the characterization of consonants, representing palatality, labiality and lowness respectively. In addition, Kaye et al. (1990) propose another three elements, [R], [ʔ] and [h], defined respectively as follows. In acoustic terms, [R] is recognized for ‘a second-formant transition characteristic of a coronal gesture’. Independently, it represents a coronal tap [ɾ]. The element [ʔ] is characterized by ‘an abrupt decrease in overall amplitude’ and is interpreted as a glottal stop /ʔ/ when occurring alone. The element [h] represents a noise with ‘high-frequency aperiodic energy’ that features the ‘turbulent airflow’ in fricatives and affricates and the ‘noise burst’ in plosives. In isolation, it is realized as a glottal fricative /h/ (Harris 1990:263). Incorporated into the mechanism of head-dependent relation, these elements can represent a wide range of consonants. Some examples are provided in (19) (where x represents a skeletal position):

(19)

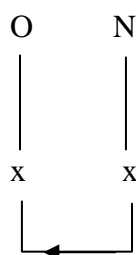
s	θ	t	ʃ	f
x	x	x	x	x
				<u>h</u>
<u>h</u>	h	h	<u>h</u>	
				U
R	<u>R</u>	R	R	
		ʔ	I	

Harris (1990:256) argues that the set of privative elements enables GP to explain phonological events in terms of either ‘composition’ or ‘decomposition’; the former is the fusion of a segment with other elements spreading from an adjacent segment, and the latter refers to the loss of elements from the internal structure of a segment. Recall the discussion about the monothongization of diphthongs above, we have already seen in both PP and DP how element-based approaches are able to offer a non-arbitrary account to the output of a fusion process. GP not only shares with these two theories the ability to predict possible outcome of composition but also attempts to provide a reason for the loss of elements from a segment occupying a particular position in a syllable. In what follows, I will introduce two important assumption of GP: phonological licensing and segmental complexity, which will figure in the discussion in §3.

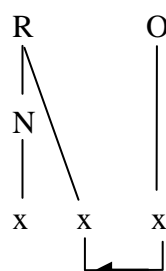
In GP, an important principle is the notion of phonological licensing, which states that ‘within a domain, all phonological units must be licensed save one, the head of the domain’ (Harris 1994a:156), while possible domains include the foot, syllabic constituents, skeletal positions and so on, with the former placed higher on the prosodic hierarchy than the latter two. Thus, the presence of a phonological unit has to be sanctioned by the presence of its licensor. Some licensing relations that will become relevant in latter discussions are illustrated in (20) (where O stands for onset, N for nucleus and R for rhyme).

(20)

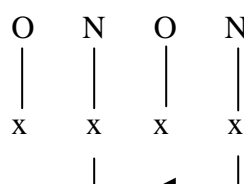
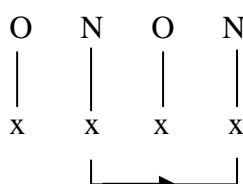
(a) Onset Licensing



(b) Coda Licensing



(c) Nuclear projection



Worth noticing is that, in languages such as English, where a closed-syllable as ‘(C)VC’ is allowed, an empty final nucleus is sanctioned by the phonological system of the language, which Harris refers to as the ‘final-empty-nucleus parameter’, whereas in some languages, the system does not sanction an empty nucleus and thus a final consonant is not allowed since its licenser, the final empty nucleus, is not licensed.

Among the licensing relations illustrated above, (20b) further belongs to a special case of licensing –the government relation, defined by Kaye et al. (1990) as an ‘asymmetric relation holding between two skeletal positions’ in a phonological string. Harris (1990) recognizes three types of governing relations, that is, between the two skeletal positions of a branching onset or nucleus as well as between a coda and a following onset. According to Kaye et al. (1990:198), government relation is characterised as ‘strictly local’ and ‘strictly directional’. The condition of strict locality demands that the governor and the governee be adjacent to each other, and the strict directionality assumes that the projection of governing relation initiates from the

head of a constituent. Thus, the governing relations are rightwards within a branching onset or nucleus and leftwards between a coda and the following onset. The governing relation plays an important role in determining what segments are allowed to occupy a particular skeletal position within a syllable. A universal phonotactic principle underlying this mechanism is the Complexity Condition, which states that a governed segment should not be more complex than its governor with respect to the internal structure (Harris 1994a:170). That is, the number of elements in the representation of a governee should not be more than that of its governor. The concept is also crucial to the loss of element in lenition processes and will figure in the discussion in §3.

§ 2.4 Summary

In this chapter I have introduced a segmental representation theory, Element Theory, which bases its notation on privative phonological constituents. Theories within this framework, including Particle Phonology, Dependency Phonology and Government Phonology, differ with regard to the sets of elements and the representational devices they utilize, yet in general they share the following aspects. First, they all establish their proposal on three basic vocalic elements [I], [U] and [A]. Second, the elements proposed in these theories, however different, are all single-valued. Third, they generally prefer a small feature inventory. Fourth, the elements are defined in both articulatory and acoustic terms. These characteristics lead to a theory that is more constrained in the generation of natural classes and possible phonological processes and thus is preferable to the traditional binary system which suffers from excessive generative capacity. Having argued on a theoretical basis for element theory, I summarize some important proposals and the formal apparatus of PP, DP and GP at the end of this chapter, which will serve the basis of discussion in the case studies in the chapter below.

§ 3 Case studies

Having introduced the notational devices of three element-based theories above, in this chapter, I will evaluate the adequacy of these theories in their representations of various phonological events. Here I invoke two criteria for the evaluation. First, an adequate theory of representation should be able to ‘mirror’ phonological processes; that is, the representation should not only present the input and output of a process but also explain how the change happens where it does (Schane 1984a). For instance, if a consonant is palatalized under the influence of a following high vowel, an adequate representation would not simply show that the consonant ‘transforms’ into a palatalized consonant before a high vowel, but it is supposed to characterize the process as one where the palatality spreads from the high vowel to the preceding consonant. Second, an adequate notational theory should avoid arbitrariness in its representation. That is, any addition of features or elements to the representation should have a local source. Taking for example again the consonantal palatalization mentioned immediately above, the account is non-arbitrary since the spreading palatality is contributed by the following high vowel, yet it would be regarded as arbitrary if it is labiality that spreads, which does not exist in the internal composition of the following high vowel.

In what follows, I will test element theory with three important phonological processes: vowel shift, vowel harmony and consonantal lenition. The representation of element theory will be weighed against that of the binary approaches to see which approach can offer a non-arbitrary account that mirrors these processes.

§ 3.1 Case I: Vowel shift

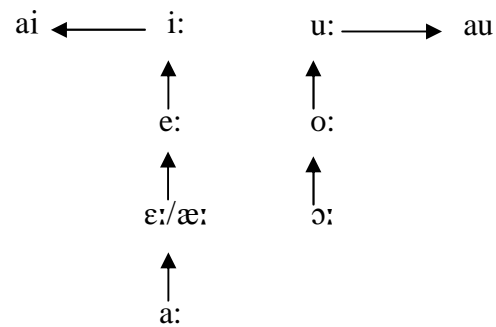
Vowel shifting is a process where vowels move up or down along the scale of vowel

height or become more to the front or the back in the vowel space. Chain shifts, however, is a special case of vowel shifting in that the place vacated by the input of a vowel shift is filled up by the output of another shift. Three general principles that concern the direction of chain shifts are provided by Labov (1994:116): (i) Long vowels rise, (ii) short nuclei of upgliding diphthongs fall, and (iii) back vowels move to the front. Labov also finds that, among the three principles, the first two apply most generally to chain shifts in the world's languages. These two principles happen to characterise a series of sound changes in the English Great Vowel Shift (henceforth GVS). Thus I consider the GVS a representative case that can serve as an appropriate subject for the analysis of vowel shifting. If a notational theory can represent the GVS appropriately, it would be applicable to a wide range of vowel shifts in the world's languages.

§ 3.1.1 The English Great Vowel Shift

The GVS is a series of interlocked vowel shifts that occurred between the 14th and the 17th centuries. During this period, all non-high long vowels climbed up gradually in the vowel space and ended up one degree higher than their original places. The high vowels /i:/ and /u:/, unable to move up further, diphthongized and eventually reached the position of /ai/ and /au/ in Modern English, as illustrated in (21) by Jespersen (1909:232).

(21) *The English Great Vowel Shift*



Though it is generally agreed that (21) represents the endpoint of the GVS, there has been much debate on how this final situation was reached. One issue concerns the first impulse that sets off the chain reaction. Some scholars (e.g. Jespersen 1909; Stockwell 1964; Stampe 1972) propose that the GVS started with the diphthongization of /i:/ and /u:/, which left the space previously occupied by the two high vowels empty and thus dragged the mid vowels up to fill the places. Others (e.g. Luick 1964; Ogura 1990; Lass 1999) argue that it was the mid vowels /e:/ and /o:/ that moved upwards first and pushed the high vowels out of place, forcing them to diphthongize. Another problem centres around the path through which the high vowels diphthongized to their present positions. One assumption shared by Jespersen (1909), Chomsky and Halle (1968) and Wolfe (1972) is /i:/→/iy/→/ei/→/əi/→/ai/, which is paralleled by the back high vowel. In their proposal, the nuclei of the diphthongized high vowels first lowered, then centralized, and then lowered again. Another view is that the centralization of the nuclei took place last in the development, following the path /i:/→/iy/→/ei/→/æi/→/ai/. It is not the purpose of this dissertation to argue for or against any of these positions, but we need to bear in mind that analyses by different scholars may be based on different assumptions about the development of the GVS.

The GVS has long posed problems for many theories of representation. One reason is that, unlike in assimilation, where the source of spreading properties can be

found in adjacent segments, the GVS is widely regarded as a context-free process, for there does not seem to be any phonetic motivation from other segments in the same phonological string (Jones 1989:204). Another problem is that the GVS is not just a bundle of unrelated vowel shifts but a chain reaction composed of two different operations –diphthongization and vowel raising. Thus it presents a challenge for any notational theory that attempts to characterize the whole event as a unified phenomenon. SPE (1968:264-5) proposes a sequence of rules to describe the GVS, reproduced as (22).

(22)

(a) Diphthongization

$$\emptyset \rightarrow \left[\begin{array}{l} - \text{vocalic} \\ - \text{consonantal} \\ \alpha \text{ back} \end{array} \right] / \left[\begin{array}{l} + \text{vocalic} \\ - \text{consonantal} \\ + \text{tense} \\ + \text{high} \\ \alpha \text{ back} \end{array} \right] \text{ —————}$$

(b) Vowel shift

$$\left[\begin{array}{l} \alpha \text{ high} \\ - \text{low} \end{array} \right] \rightarrow [- \alpha \text{ high}] / \left[\begin{array}{l} \text{—————} \\ + \text{tense} \\ + \text{stress} \end{array} \right]$$

(c) Diphthong Laxing

$$[- \text{low}] \rightarrow [- \text{tense}] / \text{—————} \left[\begin{array}{l} - \text{vocalic} \\ - \text{consonantal} \end{array} \right]$$

(d) Vowel raising

$$\left[\begin{array}{l} \alpha \text{ back} \\ \alpha \text{ round} \end{array} \right] \rightarrow [- \text{low}]$$

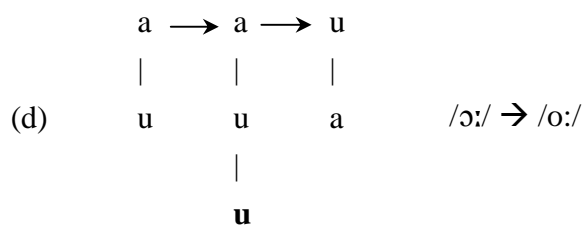
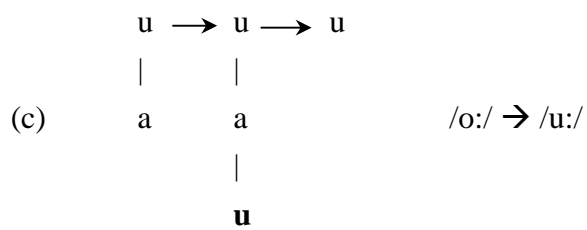
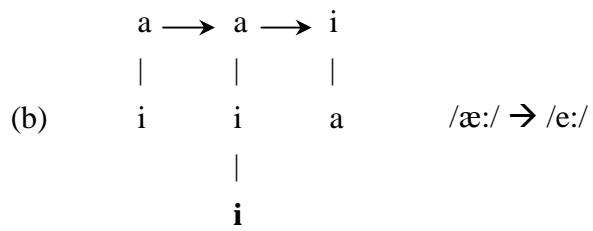
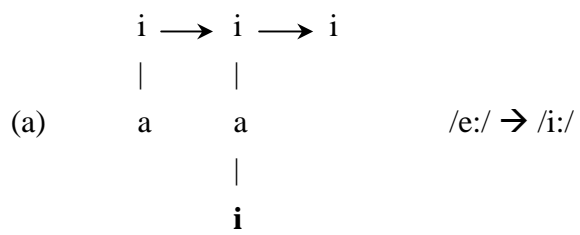
According to rule (22a), non-syllabic glides /y/ and /w/ are inserted at the end of /i:/ and /u:/ respectively, yielding two diphthongs /i:y/ and /u:w/ with long high vowels as nuclei. Next, rule (22b) exchanges high vowels with mid vowels. Hence /e:/ and /o:/ interchange with the two nuclei of the diphthongs produced by rule (22a). Rule (22c) then shortens the nuclei of the diphthongs. Finally, rule (22d) makes all vowels that agree in backness and roundness non-low, which, according to SPE, affects two low vowels /æ/ and /ɔ/. As it turns out, these rules successfully derive the correct results: the diphthongization of high vowels and the raising of all non-high long vowels by one degree. However, such representation is problematic in several aspects.

First, diphthongization is not characterized as a change in the internal structure of a monothong but an insertion of a glide from nowhere, which constitutes an arbitrary representation since the additional glide lacks any local source. It is common for a long vowel to develop into a corresponding short vowel plus a homorganic glide, yet given that the length of the high vowel remains the same, it is unlikely that the glide originates from the high vowel it follows (Schane 1984b). We are therefore unable to account for the unexpected appearance of the glides. This problem is pointed out by Schane (1984a) as a failure of traditional binary approach to capture the relationship between the internal structure of diphthongs and monothongs, as mentioned in §2.4.1. The crux of this problem lies in the use of a feature [tense] to characterize vowel length, a quantitative property, as if it is simply a qualitative one as roundness or backness. Hence a long vowel occupying two skeletal slots is represented with a single matrix just as its corresponding short vowel, only the former is specified with [+ tense] and the latter with [- tense]. Therefore when it comes to the fission of a monothong into a diphthong composed of two different halves, SPE system is forced to insert an additional matrix to the representation. The second

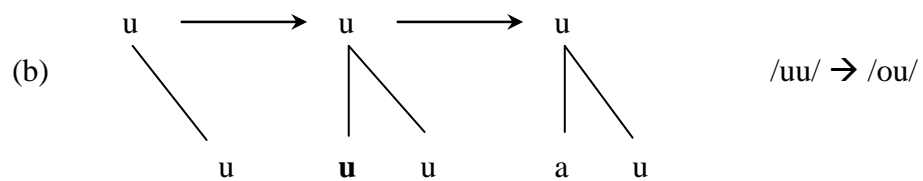
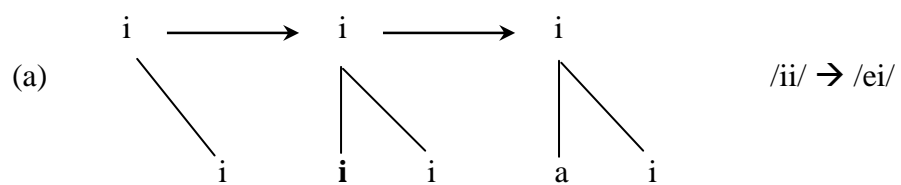
problem is the proposal of two different mechanisms to deal with a chain shift which is supposed to be a unified event (Schane 1984b). The lowering of diphthongs and the raising of mid vowels are achieved not by a vowel raising rule but by an ‘exchange rule’ (SPE:256) which switches the mid vowels with the nuclei of the diphthongs resulting from rule (22a), and only the raising of low vowels is the result of vowel raising. Such representation of a unidirectional raising process indicates the incapacity of SPE system to reflect the scalar nature of vowel heights and generalize the chain shift to a single operation (Fox 1976; Anderson & Ewen 1987).

Both the above mentioned problems are absent from an element-based representation. The following is a non-linear representation of the GVS proposed by Anderson and Jones (1977) on the basis of DP. They assume that the diphthongization of high vowels are triggered by the raising of mid vowels, so diachronically the processes follow the path (23a) –(24a) –(23b) but are presented in the following order to make the representation more revealing. Notice that long vowels in DP’s notation are supposed to be represented as diphthongs with two identical halves, as in (23), to indicate the length but are presented in (24) as their corresponding short vowels just for the reason of simplicity. A detailed explanation of this representation is in the following.

(23) Vowel raising



(24) Lowering of diphthongs



In the above representation, diphthongization of high vowels and the raising of long vowels are implemented through the same mechanism, the addition of a tonality element (as shown in bold type above), which implies that the GVS is a unidirectional process. In (23), the series of vowel shifts receive a uniform treatment. For vowels containing |i|, an additional |i| is added to the internal structure, and for those containing |u|, a |u| is added, both representing a step upwards the height scale. The scalar relationship between the inputs and the outputs of the raising processes can be seen in the change in dependency relations. In (24a), paralleled by (24b), the tonality element |i| is subjoined to the first half of the diphthong resulting from the fission of the long high vowel /i:/, yet since a segment characterized by a single tonality element is already placed at the top of the height scale and thus cannot be raised further, Anderson and Jones (1977:82), following the suggestion from Foley (1977), propose that the surplus element, which has been ‘strengthened out of’ the vowel system, ‘re-enters’ the system as the element ‘furthest from the direction of promotion’. Namely, the extra element |i|, having been squeezed out in the raising process, re-enters to the system as element |a|, which then combines with the existing tonality element in the nucleus to form a mid vowel. In so doing, they manage to provide a non-arbitrary account for the addition of |a| in the last stage in (24a) and (24b). Also, compared to (22), where no indication of a unidirectional phenomenon is shown, formulation (23) and (24) successfully characterize the GVS as a chain shift in that the space previously occupied by the input of (24a) is now taken by the output of (23a), and the vacancy left by the input of (23a) is in turn filled by the output of (23b). The same logic can be applied to (23c-d) and (24b) as well. In what follows, I present another element-based analysis that is similar to DP analysis discussed above but further attempts offer an account for the impulse of the GVS.

Though at the beginning of the section I have mentioned that the GVS is widely

regarded as a sound change without phonetic motivation, Schane (1984a; 1984b) in his analysis of the GVS not only tries to represent it as a unitary process but also attempts to provide an explanation for the impulse of mid vowel raising, which he regards as the first movement of the chain. His representation based on PP is as follows.

(25)

- | | | |
|-----|-------------|----------------------------------|
| (a) | /e:/ → /i:/ | ai i → i i |
| (b) | /i:/ → /ei/ | i i → i \dot{i} → ai \dot{i} |
| (c) | /ɛ:/ → /e:/ | aai i → ai i |
| (d) | /o:/ → /u:/ | au u → u u |
| (e) | /u:/ → /ou/ | u u → u \dot{u} → au \dot{u} |
| (f) | /ɔ:/ → /o:/ | aa <u>u</u> u → au u |

As in Anderson and Jones' formulation, all vowel raisings are implementations of the same mechanism, only this time they are characterized unitarily as the loss of an aperture particle instead of the addition of a tonality particle. The high vowels, with no aperture particle to lose, diphthongize in response to the force of mid vowel raising. Again, (25) successfully presents the GVS as a chain shift in that the vacancy left by the input of one shift is filled by the output of another shift. However, a major difference between DP's and PP's formulation lies in how they specify vowel length. While DP represents a long vowel by repeating the segmental structure of a corresponding short vowel, PP indicates vowel length with an extra tonality particle. Schane claims that PP's representation enables us to account for the raising of mid vowels in the GVS by analogy to the height assimilation of a short mid vowel to a following high vowel. He draws a parallel between the raising of mid vowels in the GVS with two height assimilation processes in early Germanic (Schane 1984a; 1984b): (i) the raising of /e/ to /i/ when the former is followed by a high vowel, and (ii)

the monothongization of /ei/ to /i:/. The two processes are formulated respectively as follows.

- (26) (a) /e/ → /i/ ai → i / ____ i
 (b) /ei/ → /i:/ ai i → i i → i i

Schane proposes that the raising of /e/ in (26a) is a process whereby a mid vowel assimilates itself to the following vowel in height. Likewise, in (26b), the raising of the nucleus in /ei/ also results from the influence of particle [i] in the following glide. Given the similarity between (25a) and (26), he argues that mid vowel raising in the GVS is also a height assimilation where the first part of the internal structure of the long vowel (as shown in bold in (25a,d)) assimilates itself in height to the following tonality particle that indicates vowel length in the representation. Thus, within the framework of PP, the initial movement of the GVS does not occur without reason but is accounted for by an intrinsic impulse that lies in the internal structure of mid vowels. Moreover, PP's notation also provides an explanation for the cross-linguistic tendency of long vowel raising in chain shifts, the first principle proposed by Labov introduced at the beginning of this section. Therefore, though both element-based analyses can characterize the GVS as a unidirectional process, I consider Schane's proposal an even better analysis of the phenomenon.

§ 3.2 Case II: Vowel harmony

Vowel harmony is a process where vowels within a word agree with respect to certain property. In some cases, a property spreads from the stem to the affixes, while in other cases it is the other way round. Thus, unlike vowel shifting, which is often regarded as a context-free sound change, vowel harmony is a type of assimilation in that the

property involved in the process spreads from one vowel to the others. Various types of harmony processes have been found in different languages, such as labiality harmony in Turkish, palatality harmony in Finnish, height harmony in Bantu languages, and so on (van der Hulst & van der Weijer 1995). Given the limited space, I will only discuss two types of vowel harmony here—the lowering harmony in Luganda and the raising harmony in Pasiego Spanish. Both these two processes have been analysed within the binary-feature and the element frameworks in the literature and thus can serve a good foundation for the comparison of the two notational systems in their representation of vowel harmony.

§ 3.2.1 *Luganda Lowering Harmony*

Luganda is a Bantu language with a five-vowel system containing /i, u, e, o, a/. It has a height harmony process operating in verb suffixes, which is similar to Chichewa, another Bantu language. In this section, I will base the discussion of Luganda height harmony on Harris (1994b), where Chichewa height harmony is discussed in details.

According to Katamba (1984), Luganda vowel harmony requires that all vowels in verb suffixes agree in height with the vowel in the root, as can be seen in (27a). However, the low vowel *a* behaves differently in that a low vowel root selects high vowel suffixes, as shown in (27b), and the verb final suffix *-a* does not participate in the harmony process.

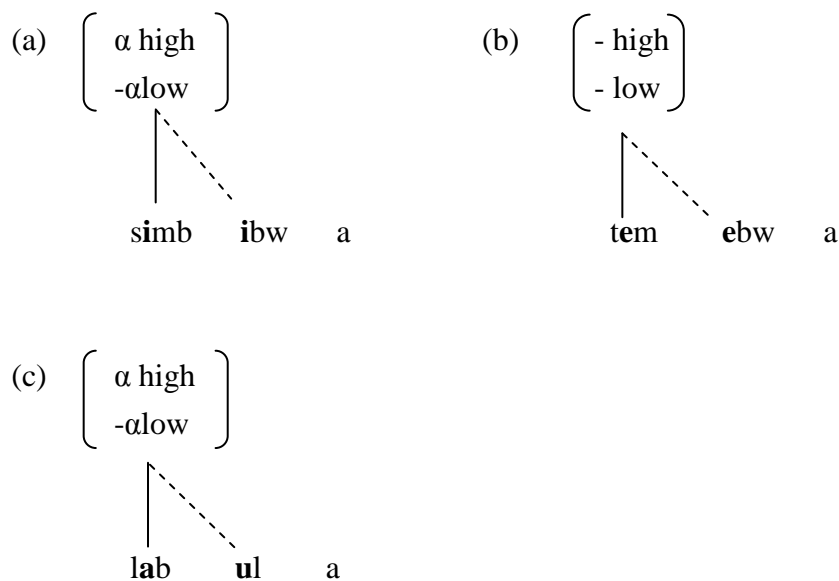
(27)

(a)	Passive	Conversive	Reciprocal	
	simb-ibw-a	simb-ul-a	simb-agan-a	‘plant’
	fumb-ibw-a	fumb-ul-a	fumb-agan-a	‘cook’
	tem-ebw-a	tem-ol-a	tem-agan-a	‘cut’
	gob-ebw a	gob-ol-a	gob-agan-a	‘chase’
(b)	lab-ibw-a	lab-ul-a	lab-agan-a	‘see’

(Katamba 1984)

To characterize the process, Katamba divides Luganda vowels into two harmonic categories: mid vowels and non-mid vowels. The mid vowels are specified as [-high, -low], while non-mid vowels may be [+high, -low] or [-high, +low], which can be collapsed into [α high, $-\alpha$ low]. In Katamba's analysis, Luganda height harmony is characterized as the spreading of height specification from the root to the following suffixes, as illustrated below.

(28)



However, the above representation has a problem. Though [α high, $-\alpha$ low] captures the distinction between mid and non-mid vowels, the use of variable implies the failure in predicting the exact height of the vowel following a non-mid root or suffix. Take (28c) for example, the minus-alpha notation might predict that the verb root *lab* spreads [-high, +low] to the following suffix, yielding incorrect form **lab-al-a* in replace of *lab-ul-a* (Harris 1994b).

Harris (1994b) argues that the problem of Katamba's representation described above is solved in Scullen's (1992) proposal, where Bantu height harmony is analysed within the framework of underspecification. In Scullen's proposal, only [-high] is

active in the process since if we assume [+ high] as the lexically specified feature that triggers the process, suffixes following a [- high, + low] root would fail to undergo height harmony and then be specified with the default value [-high] in a later stage, giving rise to incorrect results such as **lab-ebw-a* instead of *lab-ibw-a*. As a result, following Harris' (1994b) analysis of Chichewa, we can formulate Luganda height harmony as follows.

(29)

- (a) Harmonic category: [-high]
 (b) Redundant rules: [+ low] → [- high]
 [] → [+ high]

(30)

	(a) <i>temebwa</i>	(b) <i>simbibwa</i>
Harmony (29a)	<div style="text-align: center;"> <p>[-high]</p> <p>tem ebw a</p> <p>└───┘ └───┘</p> <p>(- low) (- low)</p> <p>(- back) (- back)</p> </div>	
Redundancy rules (29b)		<div style="text-align: center;"> <p>[+high] [+high]</p> <p>sim ibw a</p> <p>└───┘ └───┘</p> <p>(-low) (-low)</p> <p>(-back) (-back)</p> </div>

However, things get a bit more complicated when it comes to low vowel roots, for the non-high specification would trigger the harmony process, yielding incorrect

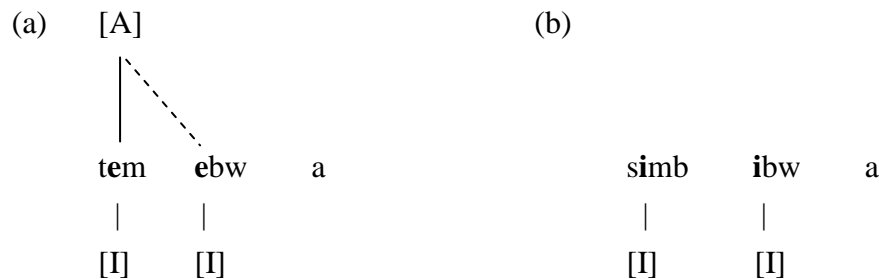
forms such as **lab-el-a* instead of *lab-ul-a*, as in Katamba's analysis (Scullen 1992). As a result, a constraint is needed to prevent the harmony process from being applied to low vowel roots before the redundancy rule in (29b) fills in the default value [+high]. Therefore, Harris discusses a 'feature-conditioned rule' to amend the problem. This rule states that [-high] can only initiate the process when it is linked to [-low]. Under such condition, a low vowel, which is specified as [-high, +low], will not trigger the harmony process.

With the supplement of a feature-conditioned rule, we are able to predict correct outputs for Luganda height harmony within the framework of underspecification. Nevertheless, Harris argues that the choice of [-low] as a condition for the spreading of [-high] is arbitrary since it is equally possible for us to choose any other features as the condition for a harmony process. In the binary framework, there is essentially no constraint on a principle basis to reject, for example, [-sonorant] or [-round] as the conditioning feature though such harmony processes may not be attested. It just happens that in the case of Luganda height harmony, the spreading of [-high] is conditioned by [-low] and we are unable to explain why [-high] must cooperate with [-low] to trigger the harmony process (Harris 1994b:521)

Though the binary system is criticized for the arbitrary condition rule, the underspecification analysis succeed in predicting the outputs of Luganda height harmony, yet it also indicates that an adequate formulation can be achieved within the privative framework since only one feature value of [high] is active in the process. Harris thus proposes an element-based analysis to characterize the process, and he argues that element theory provides a more adequate representation since the problem of arbitrary condition rule is absent within such framework. In Harris' analysis, suffixes are assumed to be lexically [A]-less; that is, they are either specified as [U] or [I], and the height harmony is characterized as the spreading of element [A]. Thus, we

can formulate Luganda height harmony as follows.

(31)



Yet again, as in the underspecification analysis, we are now facing the problem of wrong prediction in the case of low vowel roots, where [A] spreads from a low vowel to the following suffix, rendering incorrect forms as **lab-el-a* in place of *lab-il-a*. Thus, Harris proposes a mechanism to constrain the low vowel from initiating the process, which he terms the ‘tier dependency’.

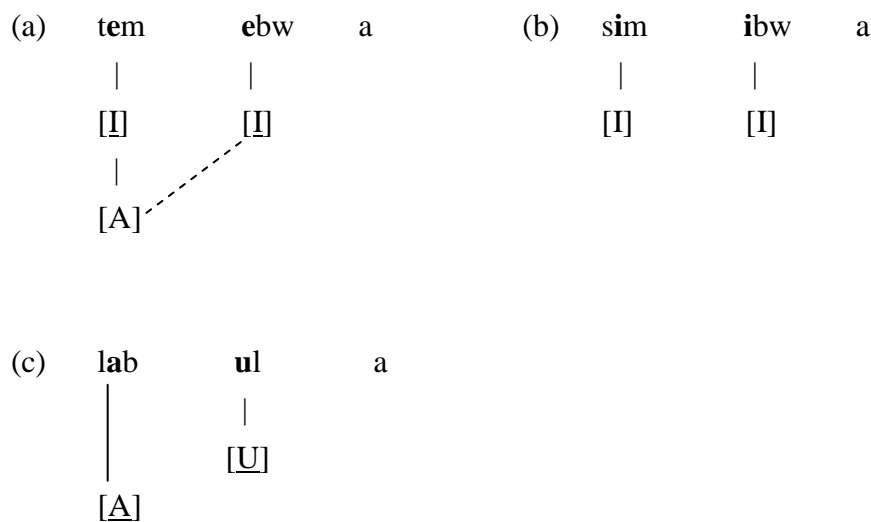
Since in element theory, one of the differences between mid vowels /e, o/ and the low vowel /a/ is the headedness of element [A], which is a dependent in the former but a head in the latter, if we want to suppress the spreading of [A] from a low vowel, we need to narrow down the harmonic category to only dependent [A] (Harris 1994b:530). In order to achieve this effect, Harris proposes that in a five-vowel system as Luganda and Chichewa, there exists a hierarchical relationship between the tiers where elements reside, and he makes the following assumption (Harris 1994b:531):

(32) An element on a dominant tier is always the head of a melodic expression.

He claims that in a vowel system containing /i,e,o,u,a/, the [I]/[U] tiers are the dominant tiers while the [A] tier is the dependent tier, which explains why the mid

vowels in Luganda are /e/ and /o/ instead of /ɛ/ and /ɔ/. Since the above assumption states that elements on dependent tiers can never be the head when fused with an element on a dominant tier, only [I, A] and [U, A], which defines /e/ and /o/ respectively, are allowed. This assumption is further supported by the absence of segments containing both [I] and [U] in this vowel system since, under assumption (32), it is also impossible for elements both residing in dominant tiers to fuse with each other. As a result, Luganda height harmony is reformulated as follows.

(33)



As shown in (33), the assumption of tier dependency achieves the same result as the feature-conditioned rule proposed in the underspecification analysis above, but as Harris argues, the former does not suffer from the problem of arbitrariness because the constraint it provides is derived from the structure of the vowel system.

§ 3.2.2 Pasiego Spanish raising harmony

In the above section, we have seen that the element-based analysis can better capture the nature of Luganda lowering harmony. In the following, I will discuss a case of

raising harmony, Pasiego height harmony, to see if element theory is equally adequate in characterizing such process. Pasiego is a dialect of Montanes Spanish with a nine-vowel system as follows (Vago 1988:344).

(34) Vowel system of Pasiego Spanish

tense vowel		lax vowel	
i	u	ɪ	ʊ
e	o		ɔ
	a		a

Since its height harmony does not refer to the distinction between [+tense] and [-tense], I will simply based my argument on the tense vowel set for its symmetrical organization. In Pasiego, the height harmony requires that all non-low vowels agree with the stressed vowel in height (McCarthy 1984; Vago 1988). Hence, within a word, all vowels preceding a stressed high vowel would become high, while those preceding a stressed mid vowel are required to be mid. Again, the low vowel *a* exhibits an exceptional behaviour. It is transparent in that it occurs freely in the harmonic span of a high or mid stressed vowel without blocking the process. Also, a stressed low vowel does not initiate the harmony, so vowels preceding a stressed low vowel would remain their underlying specification of height. Some examples of Pasiego height harmony are listed below.

(35)

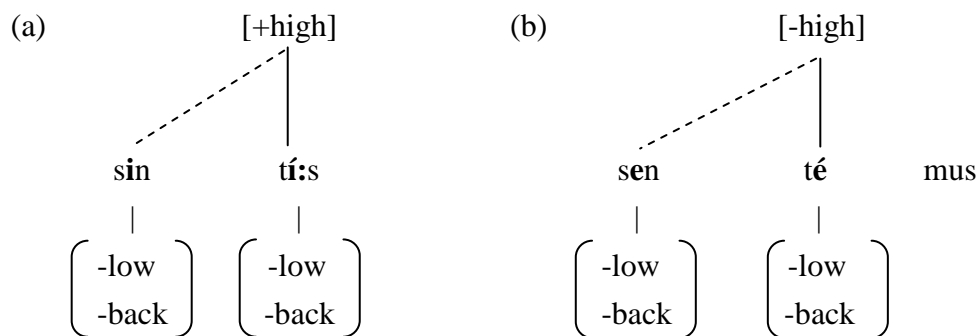
	‘to feel’	‘to take’	
(a)	sintí:s	kuxí:s	2pl. pres. ind.
	sintía	kuxía	1sg. imp. ind.
(b)	sentémus	koxémus	1pl. pres. ind.
(c)	sintámus	koxámus	1pl. pres. sub.

(d)	abidúl	‘birch tree’
	arína	‘flour’
	legatérna	‘lizard’
	kalór	‘heat’

(data from McCarthy 1984; Vago 1988)

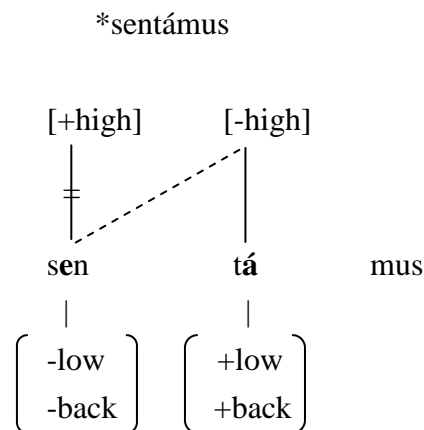
From the description above, we can derive that there are two harmonic sets in Pasiego height harmony, high vowels /i,u/ and mid vowels /e,o/. We can thus formulate the process as follows.

(36)



Since within the framework of traditional binary system, both feature values are assumed to be active in phonological processes, the height harmony is characterized as the spreading of $[\pm\text{high}]$ from a stressed vowel to its preceding vowels. However, problems arise when it comes to the case of stressed low vowel. Under the assumption that both $[\text{+high}]$ and $[\text{-high}]$ can trigger the harmony, the current analysis would predict that a stressed low vowel is always preceded by mid vowels as the result of $[\text{-high}]$ -spreading. Though the prediction conforms to cases like *koxámus*, where the underlying height specification of the root is $[\text{-high}, \text{-low}]$, it will generate incorrect results as **sentámus* (with the definition of ‘to feel’) instead of *sintámus*, where the preceding vowel is underlyingly $[\text{+high}]$, as shown in (37)

(37)



This problem can be amended if we assume that only [+high] is active in Pasiego height harmony, as proposed by Vago (1988) within the framework of underspecification theory. In Vago's treatment of this process, only the positive value of [high] is lexically specified and thus accessible to the harmony process, whereas [-high] is filled in by default rules after the harmonizing operation and therefore cannot trigger the process. In so doing, we can prevent the spreading of [-high] from a stressed low vowel to its preceding vowels and maintain the underlying height specification of the latter. The formulation in the underspecification framework is presented as follows.

(38)

- (a) Harmonic category: [+high]
Direction: right to left
- (b) Default rules: [+low] → [-high]
[] → [-high]

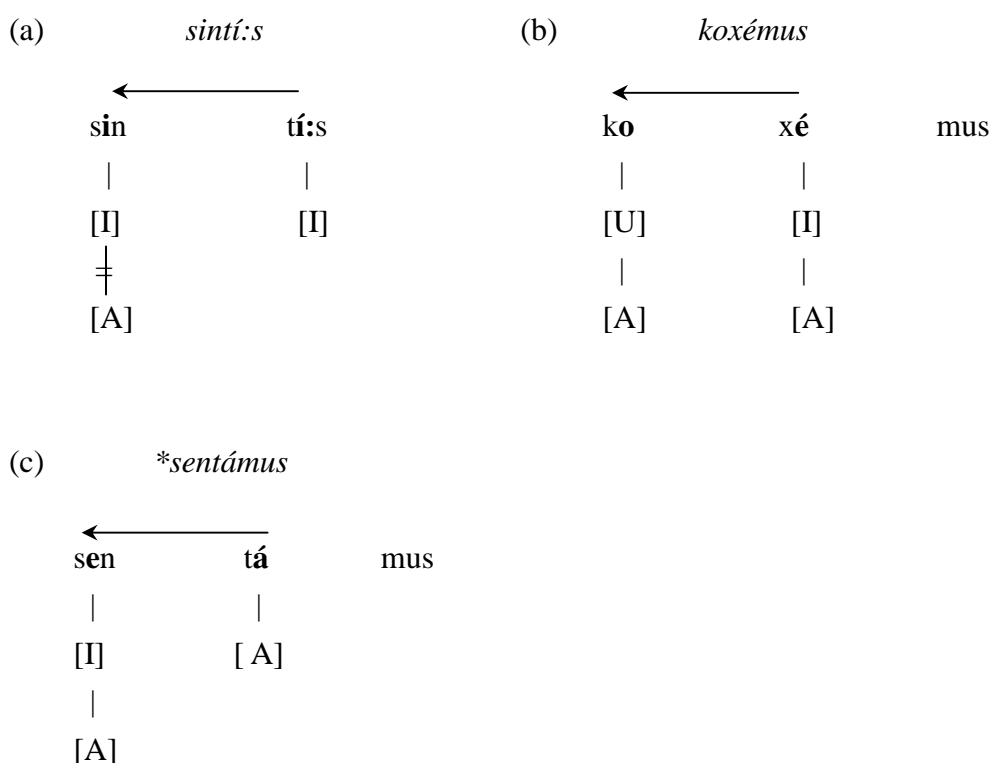
(39)

	(a) <i>sintí:s</i>	(b) <i>koxémus</i>	(c) <i>sintámus</i>
Harmony (38a)	<div style="text-align: center;"> <p>[+high]</p> <p>└───┘</p> <p>└───┘</p> <p>sin tí:s</p> <p>└──┘ └──┘</p> <p>$\begin{pmatrix} -lo \\ -bk \end{pmatrix}$ $\begin{pmatrix} -lo \\ -bk \end{pmatrix}$</p> </div>		<div style="text-align: center;"> <p>[+high]</p> <p>└──┘</p> <p>sin tá mus</p> <p>└──┘ └──┘</p> <p>$\begin{pmatrix} -lo \\ -bk \end{pmatrix}$ $\begin{pmatrix} +lo \\ +bk \end{pmatrix}$</p> </div>
Default rules (38b)		<div style="text-align: center;"> <p>[-high] [-high]</p> <p>└──┘ └──┘</p> <p>ko xé mus</p> <p>└──┘ └──┘</p> <p>$\begin{pmatrix} -lo \\ +bk \end{pmatrix}$ $\begin{pmatrix} -lo \\ -bk \end{pmatrix}$</p> </div>	<div style="text-align: center;"> <p>[+high] [-high]</p> <p>└──┘ └──┘</p> <p>sin tá mus</p> <p>└──┘ └──┘</p> <p>$\begin{pmatrix} -lo \\ -bk \end{pmatrix}$ $\begin{pmatrix} +lo \\ +bk \end{pmatrix}$</p> </div>

In the underspecification analysis above, we successfully prevent the stressed low vowel from initiating the height harmony. Moreover, /a/ is not only excluded from the harmonic sets but is also prevented from being the target of spreading [+high] since there is a universal incompatibility between [+high] and [+low]. As a result, the transparency of the low vowel is accounted for by an innate constraint of the binary feature system.

However, the success of the underspecification treatment of Pasiego height harmony seems to indicate that the process can be reanalysed in terms of single-valued elements since only one feature value is active in the operation. Since the spreading of [+high] is characterized in element theory as loss of element [A], Harris and Lindsey (1995) proposes the following formulation for Pasiego height harmony.

(40)



In representation (40), the height harmony is not characterized as feature-spreading but as the delinking of a certain element. According to Harris and Lindsey's proposal, vowels within the harmonic span have to be licensed by the stressed vowel. They assume that all vowels to the left of a stressed vowel underlyingly contain an element [A], yet under the harmony process, any [A] in the preceding vowels have to be sanctioned by the [A] in the stressed vowel, or else it will be delinked. At first sight, this treatment seems to indicate that the element analysis is unable to characterize the lowering harmony, i.e. an assimilation process, as feature spreading since the representation cannot refer to the absence of [high], which is specified as [-high] in the binary framework. However, the fact that the process can be reanalysed in terms of privative features also implies that only one feature value is actually needed in the representation.

However, as can be seen in (40c), the element-based analysis presented by Harris

and Lindsey suffers from a problem which is not present in the underspecification analysis. It erroneously predicts that a stressed low vowel is preceded by mid vowels, for the [A] in /a/ would sanction the [A]s in the vowels within the harmonic domain, yielding incorrect forms as **sentámus* instead of *sintámus*. This problem is absent from the underspecification approach because the low vowel does not contain the feature value [+high] which is accessible to the harmonizing operation, while in element theory, the low vowel can initiate the process since it contains an [A] which is addressed by the licensing relation.

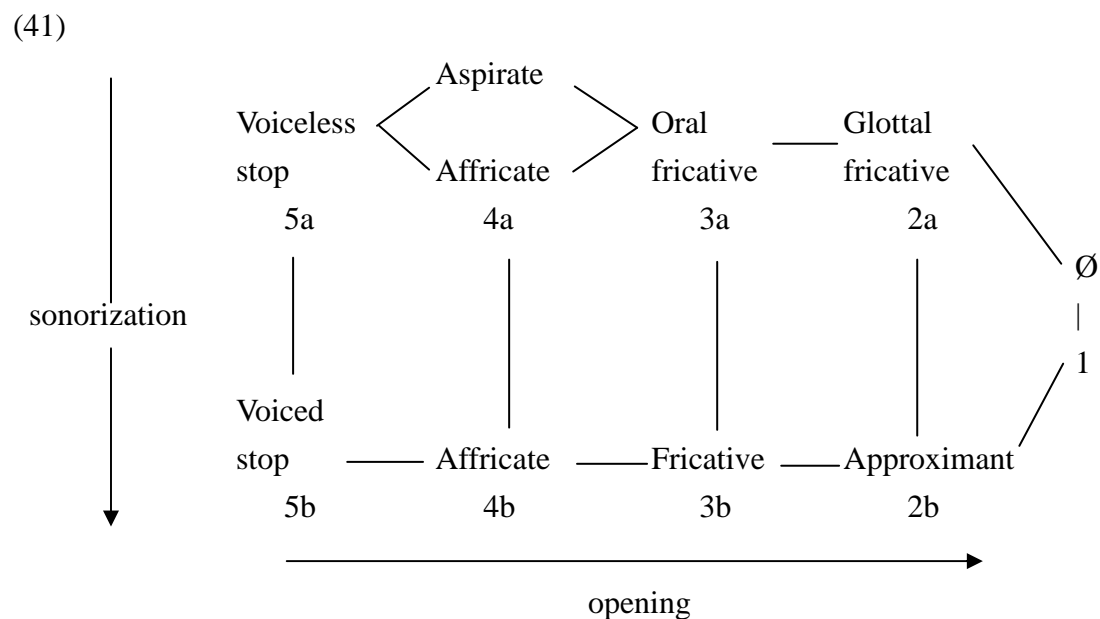
In order to fix the problem in cases like **sentámus*, we may invoke the mechanism of tier dependency proposed by Harris for Chichewa height harmony, as reported in §3.2.1, to deprive the low vowel of its legitimacy to license. However, we would instead derive incorrect results in cases where vowels in the harmonic domain are underlyingly mid. That is, by narrowing down the elements addressable by the licensing relation to only dependent [A], we make correct prediction in the case of *sintámus* but in turn produce incorrect form as **kuxámus* instead of *koxámus* since in the tier dependency framework, the head [A] in the stressed low vowel would not sanction a dependent [A] in its harmonic domain and thus gives rise to preceding high vowels. This case, however, was correctly derived before the mechanism of tier dependency is invoked. Either way, we are unable to make correct prediction in both cases. It seems that, though element theory provides a better account for Luganda harmony, it fails to capture the nature of Pasiego height harmony.

§ 3.3 Case III: Lenition

In the previous two case studies, I have discussed two phonological processes that concern with vowels. Yet an adequate theory of phonological representation should be able to characterize not only vocalic but also consonantal change. Thus in this section

I turn to consonantal lenition to see if element theory can better characterize consonantal change than traditional binary approaches.

The concept of lenition is based upon the assumption that some segments are ‘stronger’ than others. For such relative strength, Vennemann gives the following definition: ‘A segment X is said to be weaker than a segment Y if Y goes through an X stage on its way to zero’ (cited in Hyman1975:165). Also, Lass and Anderson (1975) observe that, in lenition processes throughout the history of languages, segments tend to become more open or more sonorant. A preferred route of lenition is thus illustrated as follows (Lass 1984:178)



English *t*-lenition is a phenomenon that includes a series of synchronic phonological processes embodying many of the progressions presented in (41), such as spirantization (from stage 5 to stage 3) and debuccalization (progression towards stage 2). Therefore I consider it a suitable case for the evaluation of feature-based and element-based representations for consonantal lenition, which I present in the following.

§ 3.3.1 English *t*-lenition

In different varieties of English, the alveolar plosive /t/ may have different realizations depending on its position in a phonological string. For example, Harris mentions (1990:266) that in Liverpool English, /t/ may spirantize into an /s/ after stressed nuclei or debuccalize into an /h/ at the end of function words, as shown in (42). However, Harris' description of Liverpool *t*-lenition is somewhat simplified. In fact, Watson (2006:60) found that /t/ → /h/ does not only occur at the end of function words but also polysyllabic lexical items such as *biscuit*, *chocolate* and *ticket*, where /t/ appears in an unstressed final syllable, yet since the focus of the current discussion is on phonological representation, here I do not intend to give a detailed description of the phenomenon itself.

(42)

- | | | |
|----|--------|--------|
| a. | [bes] | bet |
| | [bésə] | better |
| b. | [æh] | at |
| | [ðæh] | that |

In some other varieties of English, including American English and Australian English, /t/ is realized as an alveolar tap in the intervocalic position, as in *better* [bétə] and *pity* [pítɪ], while other varieties, such as Scottish English and London English, have a glottal stop instead, as in *water* [wɔʔə] and *city* [sɪʔi]. Moreover, in many varieties, a syllable-final *t* is often realized as an unreleased stop.

In the framework of traditional binary system, lenition processes are represented as the changing of feature values (Harris 1990). For example, spirantization of /t/ listed in (42a) involves a shift from [-continuant] to [+continuant], while process (42b) is further characterized by the shifts from both [+anterior] and [+coronal] to their

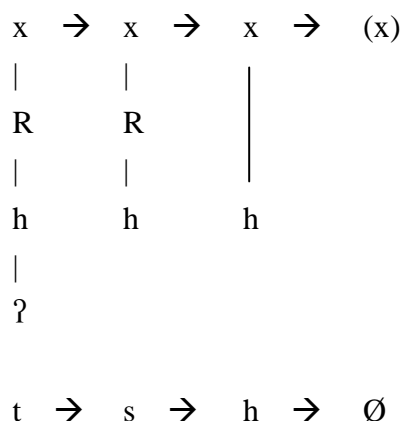
negative value. Though the traditional binary system correctly describes the input and output of a lenition process, it is inadequate as a notational system in several aspects.

First, nothing in such type of representation implies that the output of the process is weaker than the input. This problem results from the very principle of binary feature system that every segment has to be fully specified with features in order to be phonetically interpretable, and the only difference between any two segments lies in the specification of feature values. Therefore, the internal structure of the input of a lenition process is no more complex than that of the output, and thus there is no telling which segment is weaker than the other. The second problem is that, in the binary framework, various types of lenition processes do not receive a uniform treatment. As mentioned above, process (42a) involves a shift from the negative to the positive feature value, while in process (42b) it is the opposite case. It seems that the binary system provides no constraint on the direction of feature-value changing, and whether the shift is from minus to plus or plus to minus is completely arbitrary (Harris 1990). Another related problem is the overgeneration of possible lenition processes. Not only is the direction of feature-value changing unconstrained, there is also no restriction on the features that are addressable by lenition processes. Thus in principle, a given segment can weaken into any other segment within such framework, which does not reflect the fact that lenition processes tend to favour certain trajectories (Harris 1990).

Taking into account the above mentioned problems of traditional binary representation, Harris (1990; 1994a) proposes an analysis on the basis of GP, which, as he argues, not only provides lenition processes with a uniform treatment but also explains why /t/ tends to weaken in some environments. In Harris's analysis, various types of lenition are characterized unitarily as processes of decomposition, that is, loss of elements from the internal structure of segments. For example, a favoured

trajectory of lenition that follows ‘plosive → fricative → h → Ø’ (i.e. 5a→3a→2a→1 in (41)) is represented as follows (Harris 1990:269).

(43)



Following Vennemann’s definition of consonantal weakening, Harris characterizes the lenition trajectory as ‘progressive decomplexification’ (Harris 1990:268). That is, at each stage of the trajectory, an element drops from the segmental structure, yielding an output that is less complex in its composition than the segment in the previous stage. Thus, representation (43) clearly shows that segmental complexity decreases step by step on its way to zero, and therefore segments with less complex internal structure are weaker than those with more complex composition. Harris argues that the reason why lenition can be characterized as loss of element from segmental structure is that, in GP, every element is assumed to be phonetically interpretable, and thus the difference between any two segments lies in their internal compositions instead of feature-values as in traditional binary framework.

Worth noticing is that (43) does not imply that the elements can only drop in that order. In addition to spirantization and debuccalization, which are presented in (43), other types of lenition processes are also predicted under the element-based analysis. For the tapping, glottalling and unreleased /t/ as mentioned at the beginning of this

section, Harris and Lindsey (1995:125) offers the following representation.

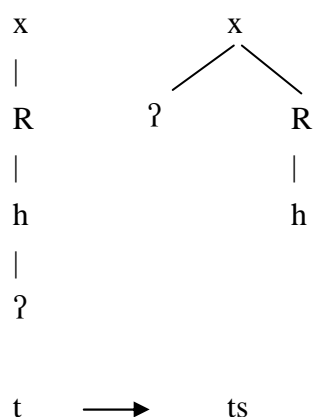
(44)

a. unreleased	b. tapped	c. glottalled
x	x	x
R	R	
ʔ		ʔ
t̚	ɾ	ʔ

In (44), the unreleased /t/ is presented as the loss of element [h] from the internal composition of /t/, and tapping is captured by a further loss of [ʔ] while glottalling by the loss of [R] instead. One of the biggest advantages of this analysis is that, unlike in binary approaches where many unattested processes are allowed in the formalism, only a limited number of lenition types are predicted in the element framework. For example, in the binary-feature framework, an unattested lenition from /t/ to /p/ can be easily represented as a shift from [+coronal] to [-coronal], while in an element-based representation, it would involve an arbitrary replacement of [R] by [U], yet since the addition of [U] lacks any local motivation, such process is not predicted in the element analysis (Harris 1990:268).

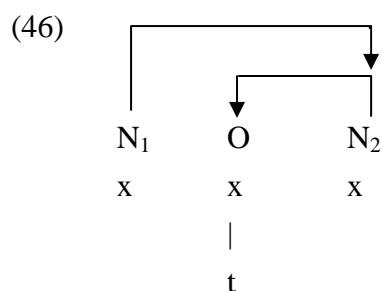
From the above representation, we can see that a wide range of lenition processes are given a uniform treatment, namely, the loss of element from the internal composition of a segment. However, such analysis is not without its limit. In dealing with the affrication, Harris provides the following representation (1990:270).

(45)



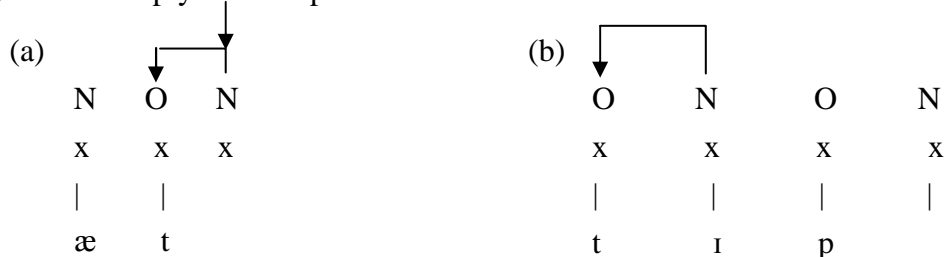
In the above analysis, affrication is characterized as ‘breaking’ of the internal composition of a plosive instead of loss of element. However, though Harris argues that ‘breaking’ is also a process of decomplexification in that both parts of the resulting affrication are less complex than the original plosive, such treatment seems to undermine the strong claim that lenition is a process of element loss (Honeybone 1999). However, in spite of the problem caused by affrication, the nature of lenition processes is still better captured in GP than in the binary framework since the former further provides an account for possible lenition sites.

I have mentioned in §2.4.3 that the principle of Phonological Licensing requires all phonological units except for the head of the domain be licensed. Harris (1994a:206) also proposes the concept of Licensing Inheritance Principle which states the licensing potential will be transmitted from a licensor to its licensee, which helps to compile phonological units into a phonological string, yet during the process of transmission the licensing potential will be diluted. Thus, an intervocalic consonant is subject to lenition because the position it occupies is licensed by a following nucleus which is in turn governed by the nucleus to its left, as illustrated below.



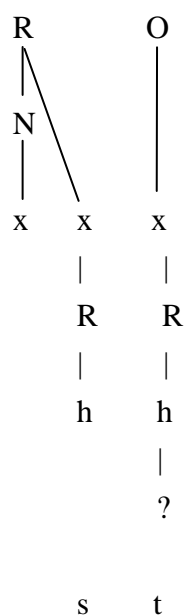
The above illustration shows that the licensing potential of the onset should be weak since it has already been transmitted through two stages from N_1 , that is, the head of the domain. As a result, an intervocalic segment tends to lenite since the skeletal position is not capable of licensing complex internal composition. Following the same line of reasoning, a word-final /t/ is subject to lenition since the position it occupies inherits its licensing capacity from a following empty nucleus which is licensed by the system at the same level, as in (47a), whereas a word-initial /t/ does not tend to weaken because the position it occupies inherits its licensing potential directly from a nucleus that is the head of the domain and thus has a greater capacity to support segmental complexity, as in (47b).

(47) Final-empty-nucleus parameter



The characterization of lenition as element loss is further supported by a context where no varieties of English seem to display *t*-lenition, that is, when /t/ is preceded by an obstruent such as /s/, which is represented below (Harris 1990:290).

(48)

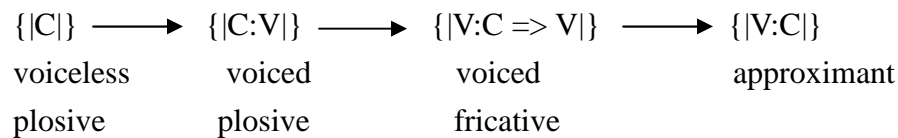


According to Harris' analysis, the coda /s/ is governed by the following /t/, and since the Complexity Condition requires that the governor be more complex than its governee with respect to internal composition, the /t/ in such context is prevented from lenition, which is indeed the case found in all the varieties of English in Harris' (1990) study. However, though this analysis generally makes some correct predictions about possible lenition sites, it does not explain why certain lenition type occurs in particular environment. For example, though Harris provides an account for the absence of lenition in the word-initial position, his analysis does not seem to explain why unreleased /t/ never occurs in an intervocalic position or why tapping never occurs word-finally before a consonant or pause. In this sense, which type of lenition will occur in which environment seems to be arbitrary.

Alternatively, Ewen and van der Hulst (2001) argue that not all lenition processes have the same cause as proposed by Harris. According to their analysis, though lenition to /h/ and /ʔ/ are processes of decomplexification, intervocalic lenition is a process where a consonant assimilates itself to the surrounding vowels with respect to the category gesture and thus should be characterized as a progression where

consonants become more vowel-like. For example, based on Anderson and Ewen's (1987:176) notation, a lenition trajectory such as 5a → 5b → 3b → 2b in (41) can be represented in DP framework as in (49):

(49)



According to Ewen and van der Hulst's characterization of intervocalic lenition, in the above representation, the phonatory component V becomes more prominent along the trajectory, indicating that the segment becomes more vowel-like. However, this analysis also suffers from the problem of arbitrariness as Harris' analysis discussed above. Though debuccalization to [h] does not occur in intervocalic position and thus is not a process of assimilation to surrounding vowels, *t*-glottaling is mainly found in intervocalic position but is not a result of categorial assimilation, which runs counter to Ewen and van der Hulst's prediction. Hence, whether an intervocalic consonant would undergo decomplexification or categorial assimilation seems to be arbitrary in the DP analysis. It seems that, though both element-based analyses can better mirror lenition processes than binary approaches, they are unable explain why different lenition types occur in different environments.

§ 3.4 Summary

In this chapter, I have discussed feature-based and element-based representations for three important phonological processes. Generally speaking, element theory seems to be a more adequate notational theory based on the discussions in this chapter since it

meets the two criteria introduced at the beginning of this chapter.

In the case of the GVS, with the proposal of four different phonological rules, SPE representation fails to characterize the phenomenon as a series of unidirectional and interlocked vowel shifts. By contrast, the element-based analyses successfully capture the nature of the GVS in that the output of one shift replaces the input of another shift, and all vowel shifts, including diphthongization and vowel raising, are results of the same operation. In DP analysis, vowel shifts are uniformly presented as the addition of [i] and [u] whereas in PP as loss of an aperture particle, both representing a step upwards the scale of vowel height. However, PP seems to be more explanatory in that it provides the first movement of the chain shift with a non-arbitrary account by drawing a parallel between the height assimilation of a mid vowel followed by a high vowel and the raising of mid vowels in the GVS, which results from the height assimilation of the first part of the internal structure to a following tonality particle.

In the case of Luganda height harmony, the traditional binary approach fails to make correct predictions about the height of vowels within the harmonic domain of a transparent low vowel. This problem, however, is solved in the framework of underspecification where only one feature value is assumed to be active in the process and a condition rule which states that [-high] can only trigger the process when linked to [-low] is applied to prevent the transparent *a* from triggering the harmonizing process. However, the proposed condition rule seems to suffer from the problem of arbitrariness since it is equally possible for us to propose other features as the condition. Thus, to solve the problem caused by the transparent *a*, Harris (1994b) proposes the mechanism of ‘tier dependency’ to further restrict the harmonic category. Unfortunately, this mechanism fails to make correct predictions in Pasiego raising harmony since it cannot generate correct results for both *koxámus* and *sintámus*. In the

former case, vowels preceding a stressed low vowel are underlyingly mid while in the latter case, they are underlyingly high. In this sense, the underspecification approach seems to be more powerful with regard to the characterization of different harmony types in spite of the arbitrariness of the condition rule.

For the consonantal lenition, the traditional binary approach fails to provide various types of lenition processes with a uniform treatment and nothing in its representation implies the relative ‘strength’ of the input and output segments. By contrast, in element-based analyses, we can see the relative strength of sounds from their segmental representation and thus predict possible lenition trajectories, though DP analysis characterizes intervocalic lenition as the assimilation of consonants to surrounding vowels while GP equals all types of lenition to element loss. Both analyses reflect the manner by which lenition processes occur, but they also have their limits. In GP analysis, where lenition is assumed to be a process of element loss, affrication is characterized as ‘breaking’ instead of loss of element. Moreover, both DP and GP analysis do not seem to provide a completely non-arbitrary account for the occurrence of different types of lenition processes in certain positions.

§ 4 Conclusion

To sum up, in this dissertation, I have argued from both theoretical and empirical perspectives that element theory is a better theory of phonological representation than the binary-feature system.

In §2, I discuss three important aspects of element theory. The proposal of single-valued element largely reduces the amount of possible natural classes and phonological processes since the representation cannot refer to the absence of an element. Thus, unlike in traditional binary approaches where ‘crazy rules’ can be

easily formulated, only the feature-value that is recurrently addressed by phonological processes is accessible to the representation in the element framework. Moreover, the proposal of a small inventory of elements also places a constraint on the generative capacity of element theory since a small number of elements will essentially allow fewer combinatory possibilities. These two proposals lead to a more constrained and thus preferable theory that is exempted from overgeneration of natural classes and phonological processes, which is a major problem of binary approaches. However, this does not indicate that element theory is a less powerful theory of representation than binary approaches since the proposal of dependency relations between elements enables element theory to utilize a small amount of elements in a more economic way. Furthermore, since element theory not only defines its phonological components in terms of articulation but also acoustics, it can capture the nature of more phonological processes than traditional binary system, which shows a bias towards the articulation, since some processes refer to the articulatory aspect of segments but others address the acoustic aspect.

In §3, I weigh the element-based representations of vowel shift, vowel harmony and consonantal lenition against the feature-based representations. The result of the evaluation shows that element theory has its limit in the characterization of Pasiego height harmony and consonantal affrication and it is unable to account for the tendency of certain types of lenition to occur in particular environments, as already summarized in the previous section. However, compared to binary approaches, element theory is still better in capturing the nature of various phonological processes in that it generally provides non-arbitrary representations that can mirror how the processes occur. Also, the comparison between element-based and feature-based representations in the case studies corresponds to the conclusion from §2 that element theory is a more constrained theory since fewer possible phonological processes are

predicted in this framework, which, for example, enables the prediction of several preferable lenition trajectories. This kind of prediction is not possible in a binary approach since it suffers from excessive generative capacity. As a result, I conclude that element theory should be regarded as a more successful approach to segmental representation than the orthodox binary feature system.

References

- Anderson, J. & C. Jones (1977). *Phonological Structure and the History of English*. Amsterdam: North-Holland Publishing Company.
- Anderson, J. M. & J. Durand (1986). Dependency Phonology. In Durand, J. (ed.) *Dependency and Non-Linear Phonology*. London: Croom Helm.
- Anderson, J. M. & C. J. Ewen (1987). *Principles of dependency phonology*. Cambridge: Cambridge University Press.
- Anderson, J. M. & C. Jones (1974). Three theses concerning phonological representations. *Journal of Linguistics* 10, 1-26.
- Archangeli, D. (1988). Aspects of Underspecification Theory. *Phonology* 5, 183-207.
- Bach, E. & R. T. Harms (1972). How Do Languages Get Crazy Rules? In Stockwell, R. P. & R. K. S. Macaulay (eds.) *Linguistic change and generative theory*. Bloomington; London: Indiana University Press.
- Browman, C. P. & L. M. Goldstein (1989). Articulatory Gestures as Phonological Units. *Phonology* 6, 201-251.
- Campbell, L. (1974). Phonological Features: Problems and Proposals. *Language* 50, 52-65.
- Chomsky, N. & M. Halle (1968). *The Sound Pattern of English*. New York: Harper & Row.
- Clements, G. N. (1991). Vowel height assimilation in Bantu languages. *Working Papers of the Cornell Phonetics Laboratory* 5, 37-76.
- Clements, G. N. (2003a). Feature Economy as a Phonological Universal. In Solé, M. J., D. Recasens & J. Romero (eds.) *Proceedings of the 15th International Congress of Phonetic Sciences*. Barcelona: Futurgraphic.
- Clements, G. N. (2003b). Feature economy in sound systems. *Phonology* 20, 287-333.

Clements, G. N. (2006). Feature Organization. In Brown, K. (ed.) *The Encyclopedia of Language and Linguistics* 2th Edition. Oxford: Elsevier Limited, 433-440.

Clements, G. N. (2009). The role of features in speech sound inventories. In Raimy, E. & C. Cairns (eds.) *Contemporary views on architecture and representations in phonology*. Cambridge: Mass: MIT Press.

Danyenko, A. & S. Vakulenko (1995). *Ukrainian*. Munich: Lincom Europa.

Dehaene-Lambertz, G. & M. Pena (2001). Electrophysiological evidence for automatic phonetic processing in neonates. *Neuroreport* 12, 3155-3158.

Dikken, M. d. & H. G. van der Hulst (1988). Segmental hierarchitecture. In van der Hulst, H. G. & N. Smith (eds.) *Features, segmental structure and harmony processes*. Dordrecht: Foris, 1-59.

Durand, J. (1990). *Generative and Non-Linear Phonology*. London: Longman.

Ewen, C. J. & H. G. van der Hulst (2001). *The Phonological Structure of Words: An Introduction*. Cambridge: Cambridge University Press.

Foley, J. (1977). *Foundations of theoretical phonology*. Cambridge: Cambridge University Press.

Fox, A. (1976). Problems with phonological chains. *Journal of Linguistics* 12, 289-310.

Giegerich, H. J. (1992). *English Phonology: An Introduction*. Cambridge: Cambridge University Press.

Goldsmith, J. (1985). Vowel Harmony in Khalkha Mongolian, Yaka, Finnish and Hungarian *Phonology Yearbook* 2, 253-275.

Halle, M. (1983). On Distinctive Features and Their Articulatory Implementation. *Natural Language and Linguistic Theory* 1, 91-105.

Halle, M. (2009). Two Comments on "The Role of Features in Phonological Inventories". In Raimy, E. & C. Cairns (eds.) *Contemporary Views on Architecture*

and Representations in Phonology. Cambridge: Mass: MIT Press.

Harris, J. (1990). Segmental complexity and phonological government. *Phonology* 7, 255-300.

Harris, J. (1994a). *English sound structure*. Oxford ; Cambridge, Mass.: Blackwell.

Harris, J. (1994b). Monovalency and opacity: Chichewa height harmony. *UCL Working Papers in Linguistics* 6, 509-547.

Harris, J. & G. Lindsey (1995). The elements of phonological representation. In Durand, J. & F. Katamba (eds.) *Frontiers of Phonology*. New York: Longman.

Honeybone, P. (1999). I blame the government. *Language Sciences* 21, 177-221.

Hyman, L. M. (1975). *Phonology : theory and analysis*. New York: Holt, Rinehart and Winston.

Itô, J. & R. Mester (1988). The Phonology of Voicing in Japanese: Theoretical Consequences for Morphological Accessibility. *Linguistic Inquiry* 17, 49-73.

Jakobson, R., G. Fant & M. Halle (1952). *Preliminaries to speech analysis*. Cambridge, Mass: MIT Press.

Jespersen, O. (1909). *A Modern English Grammar on Historical Principles. Part I: Sounds and Spellings*. London: George Allen & Unwin.

Jones, C. (1989). *A History of English Phonology*. New York: Longman.

Katamba, F. (1984). A nonlinear analysis of vowel harmony in Luganda. *Journal of Linguistics* 20, 257-275.

Kaye, J., J. Lowenstamm & J. Vergnaud (1985). The internal structure of phonological elements: a theory of charm and government. *Phonology Yearbook* 2, 305-328.

Kaye, J., J. Lowenstamm & J. Vergnaud (1990). Constituent structure and government in phonology. *Phonology* 7, 193-231.

Kiparsky, P. (1985). Some Consequences of Lexical Phonology. *Phonology Yearbook* 2, 85-138.

Labov, W. (1994). *Principles of Linguistic Change 1: Internal Factors*. Oxford: Blackwell.

Ladefoged, P. (1971). *Preliminaries to Linguistic Phonetics*. Chicago: University of Chicago Press.

Ladefoged, P. & I. Maddieson (1996). *The Sounds of the World's Languages*. Oxford: Blackwell.

Lass, R. (1976). *English phonology and phonological theory*. Cambridge: Cambridge University Press.

Lass, R. (1984). *Phonology: An Introduction to Basic Concepts*. Cambridge: Cambridge University Press.

Lass, R. (1999). Phonology and morphology. In Lass, R. (ed.) *The Cambridge History of the English Language Vol. 3 1476-1776*. Cambridge: Cambridge University Press.

Lass, R. & J. Anderson (1975). *Old English Phonology*. Cambridge: Cambridge University Press.

Liberman, A. M. & I. G. Mattingly (1985). The motor theory of speech perception revised. *Cognition* 21, 1-36.

Lindau, M. (1975). Features for vowels. *UCLA Working Papers in Phonetics* 30.

Lindau, M. (1978). Vowel features. *Language* 54, 541-563.

Lombardi, L. (1996). Postlexical rules and the status of privative features. *Phonology* 13, 1-38.

Luick, K. (1964). *Studien Zur Englischen Lautgeschichte*. New York: Johnson Reprint Corp.

McCarthy, J. J. (1984). Theoretical Consequences of Montañés Vowel Harmony.

Linguistic Inquiry 15, 291-318.

McCarthy, J. J. (1988). Feature geometry and Dependency: A Review. *Phonetica* 43, 84-108.

Ogura, M. (1990). *Dynamic Dialectology*. Tokyo: Kenkyusha.

Ohala, J. J. (1981). The listener as a source of sound change. In Masek, C. S., R. A. Hendrick & M. F. Miller (eds.) *Papers from the Parasession on Language and Behavior*. Chicago: Chicago Linguistic Society.

Ohala, J. J. (1996). Speech perception is hearing sounds, not tongues. *Journal of the Acoustical Society of America* 99, 1718-1725.

PulleyBlank, D. (1988). Vocalic underspecification in Yoruba. *Linguistic Inquiry* 19, 233-270.

Rennison, J. (1984). On tridirectional feature systems for vowels. In Durand, J. (ed.) *Dependency and Non-linear Phonology*. London: Croom Helm, 281-303.

Schane, S. A. (1972). Natural Rules in Phonology. In Stockwell, R. P. & R. K. S. Macaulay (eds.) *Linguistic Change and Generative Theory*. Bloomington; London: Indiana University Press, 199-229.

Schane, S. A. (1984a). The fundamentals of particle phonology. *Phonology Yearbook* 1, 129-155.

Schane, S. A. (1984b). Two English Vowel Movements: A Particle Analysis. In Aronoff, M. & R. T. Oehrle (eds.) *Language Sound Structure*. Cambridge, Mass.: MIT Press, 32-51.

Schane, S. A. (1995). Diphthongization in Particle Phonology. In Goldsmith, J. (ed.) *The Handbook of Phonological Theory*. Cambridge, Mass.: Blackwell, 586-608.

Schane, S. A. (2005). The Aperture Particle |a| : Its Role and Functions. In Carr, P., J. Durand & C. Ewen (eds.) *Headhood, Elements, Specification and Contrastivity*. Amsterdam: John Benjamins B.V., 313-338.

Scullen, M. E. (1992). Chichewa vowel harmony and Underspecification Theory. *Linguistic Analysis* 22, 218-245.

Sommerstein, A. H. (1977). *Modern Phonology*. London: Edward Arnold.

Stampe, D. (1972). On the natural history of diphthongs. *CLS* 8. Chicago: Chicago Linguistic Society, 578-590.

Steriade, D. (1979). Vowel harmony in Khalkha Mongolian. *MIT Working Papers in Linguistics* 1, 25-50.

Steriade, D. (1987). Redundant values. In Bosch, A., B. Need & E. Schiller (eds.) *Papers from the parasession on autosegmental and metrical phonology*, *CLS* 23. Chicago: Chicago Linguistic Society.

Steriade, D. (1995). Underspecification and markedness. In Goldsmith, J. (ed.) *Handbook of Phonological Theory*. Cambridge, Mass: Blackwell, 114-174.

Stevens, K. N. (1972). The quantal nature of speech. In David, E. E. & P. B. Denes (eds.) *Human communication: a unified view*. New York: McGraw Hill, 51-66.

Stevens, K. N. (1989). On the quantal nature of speech. *Journal of Phonetics* 17, 3-45.

Stockwell, R. P. (1964). On the utility of an overall pattern in historical English phonology. In Lunt, H. (ed.) *Proceedings of the Ninth International Congress of Linguists*. Hague: Mouton, 663-671.

Vago, R. M. (1988). Underspecification in the height harmony system of Pasiego. *Phonology* 5, 343-362.

van der Hulst, H. (1992). The phonetic and phonological basis of the Simplex Feature Hypothesis. In Dressler, W. U., H. C. Luschützky, O. E. Pfeiffer & J. Rennison (eds.) *Phonologica 1988*. Cambridge: Cambridge University Press.

Van der Hulst, H. (2006). Dependency Phonology. In Brown, K. (ed.) *The encyclopedia of language and linguistics*. 2nd edition. Oxford: Elsevier, 451-458.

van der Hulst, H. & J. van der Weijer (1995). Vowel Harmony. In Goldsmith, J. (ed.)

The Handbook of Phonological Theory. Cambridge, Mass.: Blackwell.

van der Hulst, H. G. (1989). Atoms of segmental structure: components, gestures and dependency. *Phonology* 6, 253-284.

Watson, K. (2006). Phonological resistance and innovation in the North-West of England. *English Today* 86, 55-61.

Wetzels, W. L. & J. Mascaró (2001). The Typology of Voicing and Devoicing. *Language* 77, 207-244.

Wolfe, P. (1972). *Linguistic Change and the Great Vowel Shift in English*. Berkeley, California: University of California Press.